UNIVERSITY OF MICHIGAN
JUL 2 1951
PERIODICAL READING ROOM

NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

VOL. 167, No. 4259 SATURDAY, JUNE 16, 1951 ONE SHILLING & SIXPENCE

C. BAKER LONDON
ESTAB. 1765

LARGE READING TELESCOPE

Definite improvements have been embodied in this reading telescope which has been designed for general use in laboratories, and for reading a galvanometer scale by reflection off the galvanometer mirror, the scale being held in a clamp on the telescope carriage. Innumerable uses will suggest themselves for this instrument in works and laboratories.

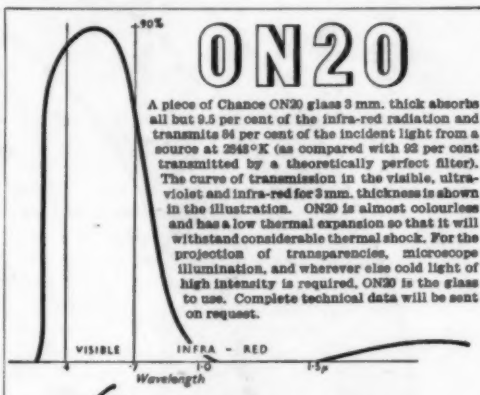
DELIVERY FROM STOCK

Further details post free on application

C. BAKER of Holborn Ltd.
244 HIGH HOLBORN
LONDON, W.C.1

Phone: HOLborn 1427 & 4004

Member Scientific Instrument Manufacturers' Assn. of Gt. Britain



ON20

A piece of Chance ON20 glass 3 mm. thick absorbs all but 9.5 per cent of the infra-red radiation and transmits 84 per cent of the incident light from a source at 2848°K (as compared with 92 per cent transmitted by a theoretically perfect filter). The curve of transmission in the visible, ultra-violet and infra-red for 3 mm. thickness is shown in the illustration. ON20 is almost colourless and has a low thermal expansion so that it will withstand considerable thermal shock. For the projection of transparencies, microscope illumination, and wherever else cold light of high intensity is required, ON20 is the glass to use. Complete technical data will be sent on request.

A Chance PRODUCT

CHANCE BROTHERS LIMITED, Glass Works, Smethwick 40, Birmingham. Telephone: West Bromwich 1051. *LONDON OFFICE*: 28 St. James's Square, S.W.1. Telephone: WHitehall 8009. *BRANCH WORKS*: Glasgow, St. Helens and Malvern.

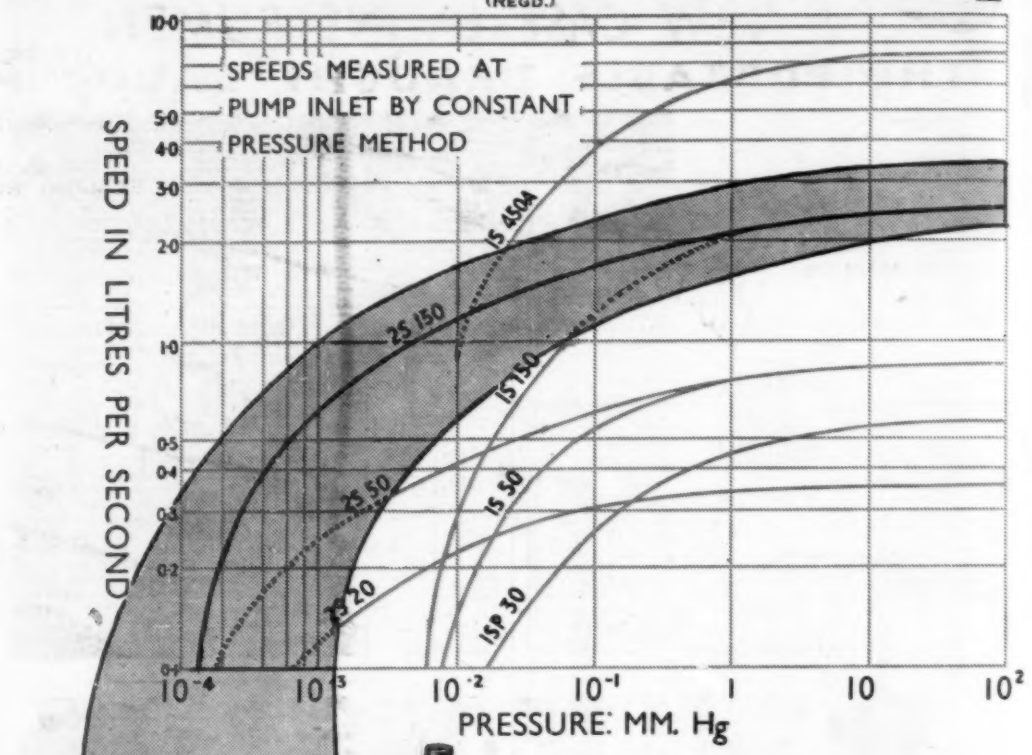
BTL
THE HALLMARK OF LABORATORY APPARATUS

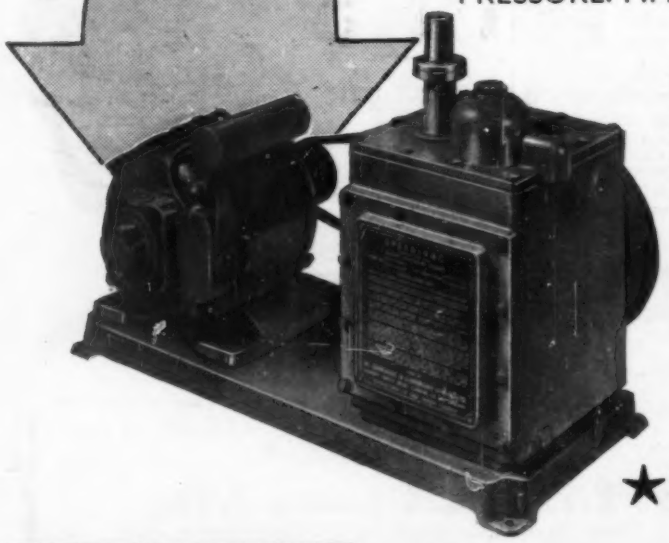
BALANCES • CENTRIFUGES • OVENS
STILLS & GLASSWARE • SPECIALISED APPARATUS
EQUIPMENT AND INSTRUMENTS

BAIRD & TATLOCK (LONDON) LTD.
Scientific Instrument Makers
FRESHWATER ROAD, CHADWELL HEATH, ESSEX

A New 'SPEEDIVAC' Pump

(REGD.)





★ **TWO-STAGE**

★ **QUIET RUNNING**

★ **COMPACT**

Although the new Speedivac 2S150 finds immediate application in the electronic fields for the exhausting of vacuum tubes, etc., many highly successful applications are reported from medical, metallurgical and chemical fields.

★ ***See our exhibits at the British Instrument Industries Exhibition***

W. EDWARDS & CO. (LONDON) LTD.
LOWER SYDENHAM · LONDON · S.E.26

...For better vacuum service

30 YEARS VACUUM EXPERIENCE

Telephone: SYDenham 7026 (8 lines)

Telegrams: Edcohivac, Souphone, London.

NATURE

No. 4259 SATURDAY, JUNE 16, 1951 Vol. 167

CONTENTS

	Page
University Expenditure	957
Behaviour of Colloidal Rocket Propellants. By Dr. H. H. M. Pike	959
Chemicals Produced from Petroleum. By A. C. Cavell	960
Fishing Techniques throughout the World. By Dr. C. F. Hickling, C.M.G.	960
Physics, Physiology and Psychology of Colour. By G. R. Noakes	961
Text-book of Basic Mycology. By Dr. G. R. Bisby	961
Algebraic Curves. By Prof. H. T. H. Piaggio	962
Monograph on Ionization Counters. By Dr. U. W. Arndt	962
Fifth Centenary of the University of Glasgow. By Prof. J. W. Cook, F.R.S.	964
Crystallography in Modern Science. By Dr. F. A. Bannister	965
The Royal Academy, 1951. By Dr. A. Tindell Hopwood	968
Obituary: Mr. Thomas Henry Court	969
News and Views	970
Reduction of Glutathione by Co-enzyme II. By Dr. L. W. Mapson and Prof. David R. Goddard; Dr. Eric E. Conn and Prof. Birgit Vennesland	975
Some Reactions in the Iron–Carbon System: Application to the Tempering of Martensite. By L. J. E. Hofer and E. M. Cohn	977
Nutritional Factors in Reproductive Failure. By Dr. B. P. Wiesner and Prof. John Yudkin	979
A Variable-Ratio Sample-Divider for Granular Materials and Powders. By Dr. E. A. C. Chamberlain, Dr. J. B. Caldwell and Dr. P. L. Waters	980
Movements of Salmon along the Coasts of Northern Ireland. By Arthur E. J. Went	981
Taxodiaceous Conifers. By Prof. Tom M. Harris, F.R.S.	982
British Iron and Steel Research Association, 1946–50. By Prof. F. C. Thompson	982
Letters to the Editors: The Theory of Magnetic Storms and Auroras.—Prof. H. Alfvén; Dr. D. F. Martyn, F.R.S.	984
Geomagnetic Effects of Solar Flares.—D. H. McIntosh	985
Inflammability Ranges of Propane–Air Mixtures under Reduced Pressure.—R. Delbourgo and P. Laffitte	985
g-Factors of Binary Ferrites at Low Temperature.—Prof. Toshiko Okamura and Yosiharu Torizuka	986
Triphenylchloroethylene, Trityimethyl Chloride and Related Halides.—J. C. Charlton, Dr. I. Dostrovsky and Prof. E. D. Hughes, F.R.S.	986
Steric Retardation and Steric Acceleration.—F. Brown, T. D. Davies, Dr. I. Dostrovsky, O. J. Evans and Prof. E. D. Hughes, F.R.S.	987
Synergistic Effect of a Third Active Glycoside of Senna.—Dr. J. W. Fairbairn and M. R. I. Saleh	988
Tissue Mecabolism and Peripheral Circulation.—Prof. B. Issekutz, jun., I. Lichtneckert, Z. Németh-Gáspár and G. Hetényi, jun.	988
Continuous Metabolism of Hæmoglobin in the Red Cells of Peripheral Blood.—Prof. H. Bénard, Prof. A. Gajdos and M. Gajdos-Török	989
Action of Vitamin B_{12}, Folic Acid and Liver Extracts on the Free Protoporphyrin Content of Red Blood Cells.—Prof. H. Bénard, Prof. A. Gajdos and M. Gajdos-Török	990
Effects of Choline, Acetate and Citrate on the Activity of the Choline Acetylating System of Mammalian Brain.—W. E. Balfour and Dr. Catherine O. Hebb	991
'Fibrino-Peptide': New Aspects of the Fibrinogen–Fibrin Transformation.—L. Lorand	992
Influence of Light upon the Hatching of Winter-Eggs of the Fruit Tree Red Spider.—H. J. Hueck	993
Epigastric Gland of *Tarsius*.—Dr. W. C. Osman Hill	994
Observations on the Type A Toxin of *Clostridium botulinum*.—Uriel Littauer	994
Identity of Frequentic Acid and Citromycetin.—John Frederick Grove and Dr. P. W. Brian	995
A Cross-Reaction in Resistance to Antibiotics.—F. Bergersen	995
Antifungal Agents from the Bark of *Populus candicans*.—H. L. Klöpping and G. J. M. van der Kerk	996
Calculation of the Digestibility of the Protein in Silage.—A. John G. Barnett and T. B. Miller	997
Virus of Enzootic Abortion in Ewes: Antigenic Relationship with Viruses of the Psittacosis Group.—C. F. Barwell and L. W. J. Bishop	998
Blood Groups of Brazilian Indians.—Mrs. A. M. Pantin and Dr. P. C. Junqueira	998
A Serious Sugar-cane Disease in British Guiana.—P. B. Hutchinson and W. T. Dale	998

UNIVERSITY EXPENDITURE

THE Chancellor of the Exchequer observed in his Budget speech on April 10 that major reductions in government expenditure could only be achieved by such measures as the reduction of food subsidies or economies in the social services; nevertheless it should not be inferred that smaller economies are either unnecessary or unlikely to be made. The diversion of resources to rearmament must force any government, irrespective of party, to weigh carefully any proposed expenditure and to disregard no opportunities of saving that can wisely be made. Even if expenditure remains at its present level, economies will still be required in view of rising prices, and a re-assessment of priorities and redistribution of effort will be necessary to keep expenditure within the limits sanctioned.

In present circumstances, no expenditure should be regarded as sacrosanct: even in essential services, the nation should be satisfied that it is getting full value, and that there is no waste of man-power, money or other material resources. Excluding the small part under the heading of Scientific Research in the Post Office vote, and the part of the £23,472,525 for the universities and colleges, etc., of Great Britain which may be spent on research, a statement included in the Civil Estimates for 1951–52 puts the national expenditure on research and development at £141,183,361. Of this, approximately £110,000,000 is for the Ministry of Supply; against this figure, £5,321,000 for the Department of Scientific and Industrial Research, £1,902,550 for the Medical Research Council and rather more than £2,600,000 for research under the Agricultural Research Council and the Ministry of Agriculture and Fisheries look almost trivial. Nevertheless, they are significant amounts, and to the £23 millions for the universities has to be added more than £7 millions in the Ministry of Education vote for scholarships and maintenance allowances at universities or like institutions, besides the cost of local education authority scholarships, which amounted to £2,150,000 in 1948–49.

Compared with the estimates for 1950–51, the figures on the whole show little change: the estimate for the universities is up by about £50,000 and that for the Department of Scientific and Industrial Research by just under £1 million on the actual expenditure in 1949–50. Nevertheless, it is wise to assume that, apart from the effect of increasing costs, all such institutions and establishments will encounter more stringent times in the next few years. In one respect, indeed, there is already a significant decrease. The estimate for scholarships and awards under the Ministry of Education is some £4,000,000 lower than that for 1950–51, and it is understood that the proposed estimate would reduce the annual intake of university students from more than 22,000 to about 18,000.

This is not, at the present time, necessarily a retrograde step. Already by 1948–49, with roughly 84,000 students, the universities of Britain had pro-

vided approximately the expansion recommended by the Barlow Report on scientific man-power and other reports on university expansion. With some few exceptions, such as chemists, chemical engineers and metallurgists, the universities seem to be meeting the current demand for graduates in science. Statistics also suggest that although more arts graduates are becoming available each year, the appointments officers and university appointments boards are keeping pace with the supply. On the other hand, while there is little, if any, evidence from the schools that boys who ought to be received in a university are failing to gain admittance—although not always at the university of their choice—there is a residue of students who, by well-tried standards, should not be there at all.

What is important in such circumstances is that the universities should seek to consolidate the ground they have gained in the post-war years and to clarify their own ideas as to policy. Even a temporary halt in expansion—and much more any permanent or long-term policy of reduction—is likely to be planned and executed much more wisely as a result of policy formulated by the universities themselves than by Treasury fiat. The universities would undoubtedly be prudent to use whatever breathing-space the delays in building schemes, now estimated to be at least six to nine months behind schedule, may afford them for consolidation and the maintenance of standards.

Here something is to be learnt from the cuts recently imposed upon the work of the British Council. The last annual report of the Council referred, indeed, to the necessity of curtailing expenditure to meet the serious position created by the sudden devaluation of sterling in September 1949, and stated that in preparing estimates for 1950–51 the Council was called upon to make a further reduction of £325,000. A total reduction of £442,000 in annual expenditure in less than two years involved, as the report for 1949–50 emphasized, major changes in the Council's policy and operations. The further reduction of £364,000 now required, which has led to the closing of the hostels for overseas university students, for whose care the Council accepted formal responsibility only last year, affects the Council's work to an extent which may well make effective planning of its operations by the Council itself impossible. Any idea that the work of the British Council offers opportunities for considerable administrative economies should be dispelled by the fact that the Select Committee on Estimates in April 1948 congratulated the Council on its administrative arrangements. The allocation to the British Council from the Foreign Office vote for 1951–52 of £1,862,000 represents a reduction of £364,000, and it is expected that the allocation of £1,007,600 from the Colonial Office—making a total cut of some £600,000—will be proportionately reduced. These cuts must thus seriously affect the work of the Council abroad, and probably also the aid given to overseas students and scholars in Britain. They will equally enforce fresh scrutiny of its work in relation to that of other agencies in the fields which it covers. It should be remembered, however, that some at least of the activities on which in recent years the Council has been encouraged to embark can bear fruit only over a long period. Sudden and haphazard slashing of expenditure is probably the most wasteful course that could be adopted, and proper economy in the work of such an institution as the British Council can only be secured by clear decision on the Government's part as to the services which it expects the Council to perform, and by giving the Council an assurance of financial stability at whatever level the nation's finances permit.

In at least one or two respects, the work of the British Council touches on that of the universities, and though it would appear from Mr. J. Dugdale's reply to questions in the House of Commons on April 18 that no serious concern need be felt as to the effects of the closing, for economy reasons, of the Council's hostels for university students from overseas in Manchester and Leeds, there would appear to be room for some closer liaison here with the universities. The Secretary of State for the Colonies rightly pointed out that accommodation in special hostels is not necessarily the ideal solution of the problem, and that it might be much better for overseas students to be housed in university halls of residence or found accommodation with families. The British Council is making every effort to do this, and has already found accommodation for four out of the five Colonial students in residence at the Manchester hostel, and will also do so for the eight students residing at the Leeds hostel, which is not to close until July.

Mr. Dugdale also stated that a sum of £425,000 has been set aside from funds available under the Colonial Development and Welfare Acts for the British Council's work for Colonial students from January 1950 to March 1954. This provides for one hostel for men students and one for women students in London, and, for the present, for the maintenance of a hostel for men students at Edinburgh and another at Newcastle, housing in all about three hundred students. Most of the six thousand overseas students, about a third of whom are in London, however, live in university accommodation, in private hostels, in lodgings or with families, and the Council has staff to help students to find such accommodation in every university centre in the United Kingdom and Northern Ireland. It was hoped that when the Council, little more than a year ago, took over from the Colonial Office responsibility for the welfare of students from the Colonies, that it would be possible to make the hostels something more like the ordinary university halls of residence. There may well be, as has been suggested in correspondence arising out of this closure of hostels, opportunities for some administrative economies in staffing and running such hostels; but the main result of the present position should surely be to strengthen the case for adequate extension of the university halls of residence. If overseas students can be provided with places in such halls, their needs may be better met than in the special hostels run by the Council.

The issue may well turn on the question of numbers, and here again it should be noted that those who urge that the question of the number of university students in general requires reconsideration at the present time are prepared to restrict numbers so as to give the universities an opportunity of putting an end to the overcrowding which militates against high standards. They lay the emphasis first on establishing conditions for creative work—for staff as well as for students. Apart from such wider questions as the appropriate balance between the arts and the science side, and the position of technological studies, having fuller regard to the fact that the university is not the only form of advanced education, investment in adequate library provision, travel grants and research scholarships and those amenities which facilitate contacts between students may be a wise step at the present time, even if such expenditure involves fewer university awards by local authorities, for example.

This aspect of the work of the British Council requires consideration in relation to that of the universities and particularly in regard to the extent to which adequate provision is made for the extension of libraries, halls of residence and the like, which were strongly urged by the University Grants Committee in its last report. The overseas student in this respect does not differ from other students: he will gain most from a university according to the extent to which he participates in the general undergraduate life. In his recent life of Lord Keynes, R. F. Harrod observes, in respect of education at Oxford and Cambridge, that discussion with other undergraduates has, by general consent, played a large part in stimulating the creative and logical powers and in assisting the transition from the commonplace to the mature mind.

It is encouraging to find this point so well stressed in the pamphlet "Introduction to a University" which has recently been published by the University of Birmingham. The pamphlet is, indeed, intended to give guidance on university education, and the careers open to students, to the sixth forms of schools. It does this in a way which should both help those who ultimately enter the university to profit most fully from what the university has to offer and, no less important, assist others who are in outlook, temperament or in other ways unsuitable for a university course to decide against seeking to enter a university.

Reduction of university expenditure may well be a false economy for the nation, even when defence requirements are more stringent; but that is not to say there are no opportunities for eliminating unessentials at present. It does mean, however, that the universities should be clear as to priorities and as to the ways in which standards can best be maintained. Above all, it supplies a further compelling reason for placing the responsibility for the general oversight and distribution of Exchequer grants to universities and to higher technological institutions fairly and squarely on the shoulders of one body.

BEHAVIOUR OF COLLOIDAL ROCKET PROPELLANTS

Internal Ballistics of Solid-Fuel Rockets

Military Rockets using Dry-processed Double-Base Propellant as Fuel. By R. N. Wimpress. Pp. xii+214. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 38*s*. 6*d*.

THIS book is limited to work carried out at the California Institute of Technology, and is mainly on one colloidal propellant, J.P.N. Nevertheless, it gives a fair summary of most of the work on colloidal rocket propellants carried out in Allied countries, and to some extent in Germany too, up to 1945. In other laboratories other propellants gave rise to the same problems, which were tackled in much the same way. For example, British workers were using interrupted burning techniques to study erosive burning in 1941, the phenomenon having been noted after unpredicted interruptions some years earlier.

The book starts with a description of the thermodynamic properties of propellant gases and methods of calculating them, followed by a description of the dependence of burning-rate on physical factors such as pressure and gas flow. Next follows the simple theory of an ideal rocket with adiabatic flow through the nozzle. Modifications are then introduced to take into account the pressure gradient along the combustion chamber, frictional and turbulent losses in the gas, and the effect of gas flow on the burning-rate. In order to obtain simple analytical solutions some approximations are made, of which perhaps the most important is the assumption that the rate of burning of the propellant is everywhere equal to its average rate, so that the cross-sectional area of the propellant remains uniform along its length. Since the same approximations are made in analysing experimental firings, however, the theory must give good predictions of the behaviour of rockets the proportions of which do not differ too widely from those used in the experimental firings.

A number of minor factors affecting performance, such as heat loss to the metal wall and deformation of the propellant under stress, are treated as perturbations of the given solutions. It is interesting to note that bursting of rounds that have been heated before firing is mainly due, not to collapse of the softened propellant under longitudinal stress, but to small deformations within the elastic range, which block the conduit sufficiently to raise the pressure at the closed end of the chamber above its bursting point.

The mathematics is very simple and set out in great detail. All the results deduced are copiously illustrated by graphs, of which there are more than eighty. Sufficient numerical information is given for the design of rocket motors using J.P.N. propellant for almost any required performance, but only a little information is given for a few other propellants. The description of experimental apparatus is confined to ten pages, of which five are devoted to the Bourdon pressure gauge as modified for optical recording. One form of apparatus for interrupting burning, perhaps the most important tool in the hands of workers in this field, is also described.

While primarily a handbook for the specialist, this book may be read with interest by anyone concerned with military weapons. The production is excellent.

H. H. M. PIKE

CHEMICALS PRODUCED FROM PETROLEUM

The Petroleum Chemicals Industry

By Dr. Richard Frank Goldstein. (Industrial Chemistry Series.) Pp. xiii+449. (London: E. and F. N. Spon, Ltd., 1949.) 63*s*. net.

THE manufacture of chemicals from petroleum was started in the United States after the First World War and had reached very large proportions in that country at the beginning of the Second World War. During the same period, virtually no chemicals were manufactured from petroleum in the United Kingdom, but this serious deficiency in the British chemical industry is now being remedied by the erection of large plants in various parts of Great Britain—a development which has been encouraged by the removal of the duties on the hydrocarbon oils that are needed for chemical synthesis.

The publication of this excellent monograph on petroleum chemicals is therefore very timely; and how well the author has carried out his task can be seen from the foreword in which Sir Robert Robinson writes: "this work deserves to be termed monumental because of the labour which its preparation must have involved and because of the completeness of the survey which it affords".

In the selection of his material the author has chosen mainly those fields of industrial organic chemistry in which oil is the most economic starting material, but alternative non-petroleum routes have been included where coal and vegetable products compete, as, for example, in the manufacture of alcohol.

The book opens with a brief discussion of the composition of petroleum and its separation into its components. The reactions of the paraffins with steam, oxygen, chlorine and nitric acid are then considered. In the United States the methane–steam process,

$$CH_4 + H_2O \rightleftharpoons CO + 3H_2,$$

is now competing with the well-known water-gas reaction for the manufacture of both hydrogen and carbon monoxide–hydrogen mixtures. Thus, whereas most of the world's methyl alcohol has hitherto been obtained from coal or coke, in the United States 29 per cent was obtained from natural gas in 1946, and the projected figure for 1949 was 77 per cent.

A very comprehensive and interesting account is given of the manufacture of the olefines and of their utilization in the production of other chemicals; and the possibilities of interchange among the various types of hydrocarbons by cracking is discussed from the thermodynamic point of view by the provision of free-energy data.

The description of the manufacture of glycerol from propylene is of particular interest in view of the world shortage of this substance. The propylene is made to react with chlorine at a high temperature (500° C.) so that substitution rather than addition is the principal reaction:

$$H_2C:CH\cdot CH_3 + Cl_2 = H_2C:CH\cdot CH_2Cl + HCl.$$

The resulting allyl chloride is treated with hypochlorous acid to give glycerol dichlorhydrin,

$$CH_2Cl\cdot CH\cdot OH\cdot CH_2Cl,$$

which is then hydrolysed to glycerol by the action of aqueous caustic soda. Since fatty acids can now be prepared by the controlled oxidation of hydrocarbons, it is quite possible that an edible, all-synthetic 'natural fat' may be manufactured in future years from petroleum or even coal.

One of the major developments in the petroleum chemical industry has been the manufacture of aromatic hydrocarbons, which are not only valuable constituents of high-grade petrol but also are needed on a very large scale in chemical industry; for example, toluene for explosives, and ethyl benzene ($C_6H_5\cdot C_2H_5$) and styrene ($C_6H_5\cdot CH:CH_2$) for synthetic rubber. Benzene is ethylated by treatment with ethylene and aluminium chloride at 90° C. and then catalytically dehydrogenated to give styrene.

In the account on aldehydes, ketones, acids, acid anhydrides, esters, nitriles and amines, two substances are of particular interest, namely, glyoxal (CHO·CHO) and keten ($CH_2:C:O$). The first of these, manufactured in the United States by the catalytic oxidation of glycol with air at 250–300° C. in the presence of a copper catalyst, is used in the dimensional stabilization of rayon by the 'Sanforset' process, the glyoxal presumably forming cross-linkages with the hydroxyl group of the rayon molecule. The second is used in the manufacture of acetic anhydride and of acetic acid esters.

In the appendixes, charts are given showing the more important routes to petroleum chemicals, and for comparison the main routes to aliphatic chemicals from coal and fermentation processes are included. Statistics are also provided of world petroleum production and consumption, and of the chemicals produced from oil in the United States. The book is printed in large type which is well spaced, and both the author and publishers are to be congratulated on the production of a fine book which deserves a very warm welcome from all chemists interested in modern developments.

A. C. Cavell

FISHING TECHNIQUES THROUGHOUT THE WORLD

Fishing in Many Waters

By James Hornell. Pp. xv+210+37 plates. (Cambridge: At the University Press, 1950.) 30*s*. net.

JAMES HORNELL had an unrivalled experience of fishing all over the Old World, for he was called in to investigate and report upon the fisheries of many territories, including Malta, Palestine, Sierra Leone, Mauritius and Fiji, as well as of India, and had many years experience of fishery work in India and Ceylon. In this work, published posthumously, Hornell brings together his observations on a number of fishing methods and devices. It is not intended to be a manual of fishing, but has the anthropological approach. Modern highly industrialized fisheries are very briefly dealt with.

Hornell does not confine his attention to fish: there are chapters on methods of destroying crocodiles and alligators, on pearls and chank shells, octopus, cuttlefish and squid, and on miscellaneous marine products. The first chapter deals with weapons of the chase, such as the spear, harpoon, bow, cross-bow and blow-gun, used for capturing fish. Particularly interesting are the ancillary devices, such as lures to attract fish within striking distance, or retarders to check the flight of stricken fish. The second chapter describes simple angling devices, and how heavy fish can be played without the use of a reel.

In the third chapter, animals trained to fish, and the methods of using them, are described. Here figure the cormorants, otters, and the remora, or sucker-fish. The next chapter, on shark fishing, includes an account of this fishery in Tonga: the sharks are lassoed after being attracted by bait, rattle and invocation. In New Guinea, the lassoed fish drags a retarder until it is exhausted; in Malabar, the captured shark is floated over the gunwale of the canoe.

An authentic account of kite-fishing is given in Chapter 6, the kite being used for causing a lure to skitter on the sea surface; Chapter 7 is devoted to the fisheries for the tunny family. This chapter contains dramatic accounts of tunny fishing in the Maldives, in Japan, Polynesia and California. There is a short account of the Breton tunny fishery. In this valuable chapter are descriptions of the Japanese method of curing tunny, of the Polynesian bonito hook and lure combined, and of live-bait pole fishing in the Society Islands.

Chapter 9 gives an account of mullet fishing; these fish are powerful jumpers, and special methods have to be used. There is the horizontal veranda net, on to which the mullets fall after leaping a vertical net; this is used in Palestine, Egypt and Mauritius. In Malta, Bengal and the Far East, rafts or mats are used to receive the jumping fish; in the Far East, the vertical net may be dispensed with, the fish being caused to jump into a boat by a whitened board. In Chapter 14 there is an excellent account of the use of artificial shelters to cause fish to gather for easier capture, with examples given from all over the world, and in Chapter 16 is a description of various forms of fixed traps.

The book is well illustrated, and has thirty-six good plates at the end. C. F. HICKLING

PHYSICS, PHYSIOLOGY AND PSYCHOLOGY OF COLOUR

An Introduction to Color

By Ralph M. Evans. Pp. x+340+15 plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 36*s*. net.

THE purpose of this book, as indicated by its title, "An Introduction to Color", is literally to serve as an introduction, assuming no necessary previous knowledge of elementary optics, to the subject of colour in all its aspects. Covering the fields of physics, physiology and psychology, each approach has been developed separately so that in the later chapters general problems can be discussed from all points of view. It is chiefly intended for students and workers who are already familiar with one side of the subject and wish to widen their grasp of the whole; and there will be many such, from the physicist who has rarely taken a subjective view to the artist who wishes to understand his tools more fully, who will read it with gratitude.

The first four chapters deal with terminology and the physics of light and colour, establishing the parts played by source and surface in determining the physical nature of the radiation reaching the eye. Transmission, absorption and reflexion curves for typical surfaces and a wide variety of natural objects are discussed in detail. Next, a study of the physiology of the eye and its adaptation to brightness and colour leads on to the methods of measuring colour, and colour specification. From the psychological point of view, the part played by the attitude and interest of the observer in the perception of, and response to, colour is examined, with a wealth of illustrations. One or two of these are almost too persuasive, as when quite different photographs are used to show the result of viewing the same scene with different mental approaches; but any ungrateful reaction by the reader envious of the relative infallibility of the camera soon disappears, for the author gives several examples of technically accurate colour photographs which he shows to fall short of satisfaction as acceptable pictures of a whole scene. The later chapters describe the functions of pigments and dyes, and the effects of surface finish and polish, and there is a brief but authoritative chapter on colour in photography.

The volume is excellently produced and illustrated, and the numerous coloured plates are of a very high quality that is all too rarely allocated to scientific books. It will be welcomed as a valuable survey of the subject, in which the more important problems are discussed from several aspects and the balance between the technical and the æsthetic is well maintained. G. R. NOAKES

TEXT-BOOK OF BASIC MYCOLOGY

Morphology and Taxonomy of Fungi

By Prof. Ernst Athearn Bessey. Pp. xiii+791. (Philadelphia and Toronto: The Blakiston Company; London: Constable and Co., Ltd., 1950.) 50*s*. net.

PROF. E. A. BESSEY'S "Text-book of Mycology" has been an introduction or an aid to many students since 1935. These and other students have participated in the great expansion of pure and applied mycology. Numerous books and countless papers have been published on penicillin and other antibiotics, on medical mycology, microbiology, chemistry and physiology of fungi, and on plant pathology, and the author leaves these fields to others. He deals with basic mycology—which is a field wide enough—with many new monographs and papers on taxonomy and morphology of fungi to integrate with the less new and the classical. Though the title has been changed in order to make it more precise, Prof. Bessey's new book is on the same lines as his text-book; but, with larger pages and more of them, it has been expanded to nearly double the size. More illustrations have been provided (now 210 figures), and many of the old ones have been improved.

The short introductory chapter gives notes on the history of mycology and on nomenclature of fungi. The Mycetozoa and related organisms have one chapter, the Phycomycetes five, Ascomycetes three, Basidiomycetes four, Fungi Imperfecti one long chapter (fifty-six pages), phylogeny one, and the literature of mycology one.

Some will consider it odd that the treatment of the 'Ascomycetæ' should start with the Laboulbeniales and end with the yeasts; but Prof. Bessey has long been interested in the phylogeny of the fungi and is entitled to group them as he thinks best. The Lecanorales (disk lichens) are treated briefly, with a key to the families and important genera. Only a paragraph is given to perithecial lichens.

The Phycomycetes, not so long ago the least-known class of Eumycetes, now appear to be the best known throughout the world. They also appeal to the teacher and to the student of phylogeny; hence the five chapters. The Basidiomycetes have been revised in the light of much recent work. At last the Fungi Imperfecti have something approaching adequate treatment.

A useful new departure by Prof. Bessey is the provision of keys to the orders, families, and many genera of the Eumycetes (including the Imperfecti). The author cannot be blamed if the best or only keys he could find for some groups are fifty years old, nor because some recent keys (for example, to the Polyporaceæ) are being superseded.

After a student has mastered the morphology and taxonomy of fungi, and forgotten many of the theories as to their phylogeny, he will still keep this book at his elbow for the literature references. Each chapter is followed by a good list of references, and finally ninety-five pages give a most useful classified guide to the literature for the identification of fungi.

Prof. Bessey's excellent book is a product of long experience that gives the student a balanced and up-to-date survey of basic mycology. It is inevitable that each specialist may find some feature he would like to alter; few could cover the vast field so well.

G. R. Bisby

ALGEBRAIC CURVES

Algebraic Curves

By Robert J. Walker. (Princeton Mathematical Series, 13.) Pp. x+201. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1950.) 25*s*. net.

THE object of this book is to give a simple introduction, on modern lines, to the subject of algebraic curves. While giving prominence to recent algebraic methods, Prof. R. J. Walker has avoided the faults of several modern authors, who have let the algebra get out of hand to such an extent as to obscure the fact that the subject treated is meant to be geometry.

Prof. Walker confines most of the algebra needed to his first chapter, on 'algebraic preliminaries'. Like the rest of the book, it is almost entirely self-contained; the principal exception is that the matrix theorems needed are quoted without proof, for which the student is referred to Bôcher's "Introduction to Higher Algebra". This chapter also includes a brief but lucid explanation of such terms as set, homomorphism, isomorphism, reflexivity, transitivity, field, integral domain, ring and group. The second chapter deals with projective spaces as far as is needed later.

After these two introductory chapters, the real subject of the book begins, with the third chapter, on plane algebraic curves. This includes a discussion of intersections, linear systems, rational curves, conics, cubics and the analysis of singularities. The fourth chapter, on formal power series, starts by recalling some theorems of analysis, for the proofs of which the student is referred to the treatises of Picard or van der Waerden. These theorems are then applied to the properties of curves, and culminate in the theorems of Bézout (whose name is given without the accent), Plücker and Nöther. The fifth chapter deals with transformations of curves, in space as well as in a plane. As a preliminary it develops the properties of rings and fields rather further than was done in the first chapter. It contains a good deal about rational functions and transformations, and includes a proof of Lüroth's theorem. The sixth and last chapter deals with linear series, which play a principal part in the investigation of such properties of a curve as are unaffected by birational transformations. The notion of a cycle is used to discuss intersections. The chapter includes the Riemann–Roch theorem and also the chief properties of the non-singular plane cubic.

The book is written in an attractive style and presents the most important theorems of modern algebraic geometry clearly and concisely. It contains an index and numerous exercises, which would be even more useful if some answers were given.

H. T. H. Piaggio

MONOGRAPH ON IONIZATION COUNTERS

Ionization Chambers and Counters

By Dr. D. H. Wilkinson. (Cambridge Monographs on Physics.) Pp. xi+266. (Cambridge: At the University Press, 1950.) 25*s*. net.

THE needs of those users of counters who work with commercially produced tubes and circuits, and who need a background knowledge of the theory of the operation of the devices and a guide to the best way of using and applying such tools, are already fairly well met by existing text-books. The present volume is deliberately written for the more advanced user who designs his own ionization counters or associated equipment and who requires all the information which an intelligently used counter or chamber is capable of furnishing. Such a reader would do well to study this volume from cover to cover.

The methods of constructing and using counters have now definitely emerged from their somewhat alchemical beginnings, but much of the information why a particular geometry or material or procedure is good or bad has not before been collected and analysed, certainly not in book form. The development has been a very rapid one: less than a third of the references quoted in this book belong to the pre-war period. One's impression on reading Dr. D. H. Wilkinson's monograph is that anything about a counter or ionization chamber which lends itself to a mathematical analysis has been so analysed here. This makes the book a difficult one to read; it contains a mass of formulæ and curves, and one often has to refer to a previous section for the meaning of a certain symbol which is used for many pages without being re-defined. However, this slight defect is understandable in a book in which, in addition to compressing so much published information, the author has the experience of a large laboratory, namely the Cavendish, in the forefront of the development, to draw upon.

After examining the relations between the energy, range and amount of ionization produced by different radiations, the amount of ionization produced inside a chamber is discussed and the profile of the pulse produced at the electrodes and at the recording device is then dealt with. The three types of ionization counters—ionization chamber, proportional counter and Geiger counter—are then treated in detail in successive chapters, there being a final chapter on the statistics of counting. There are a full bibliography and a good index.

U. W. Arndt

Animal Breeding

By Dr. A. L. Hagedoorn. (Agricultural and Horticultural Series.) Fourth edition. Pp. xx+364+16 plates. (London: Crosby Lockwood and Son, Ltd., 1950.) 15*s*. net.

SINCE the breeding and selection of animals is carried out by the farmer himself and not by a scientific specialist as in plant breeding, this book fills a pressing need, for it sets out the principles of genetics in a way that the farmer can understand. That there is a need for this is shown by the fact that it has been reprinted five times and is now in the fourth edition. The present edition contains a new chapter on Australian sheep and cattle, detailing observations made on a recent visit there, and an appendix by G. Sykes giving a detailed account of his successful adoption of Hagedoorn's theories of poultry breeding by progeny testing. This progeny testing includes testing for mortality as well as for egg production, mortality being one of the weak points of the British poultry industry before the Second World War, and one which is in danger of returning with the expansion in the poultry industry.

The success of this book is probably due to the fact that most of the chapters are based on problems which the livestock breeder is faced with, and the genetics are introduced as a solution of these problems, rather than, as in many other books, providing an exposition of genetic theories followed by a few examples of their practical application. One chapter, however, on dominance and the nature of the gene, is an exception to this rule, and the author supports his theories on this with examples from his own experiments on autosexing Barnevelder fowls and other facts.

The professional geneticist will find in the book some new aspects of his subject, for in attempting the solution of many practical problems and facts it becomes evident that formal genetics does not yet supply a complete answer. Perhaps one of the most important of these is the question of the adaptation of the animal to its environment, which is discussed in the chapters on domestication, adaptation, and improved breeds and local breeds. JOHN HAMMOND

A Dictionary of Assyrian Botany

By the late Dr. R. Campbell Thompson. (Published for the British Academy.) Pp. xv+405. (London: Oxford University Press, 1949.) 50*s*. net.

DESPITE the limitations dictated by its size and the circumstances in which it has been published, this book will be welcomed by philologists, botanists and others as a valuable work of reference, for in this age of increasing specialization it is at the cross-roads of the arts and sciences where knowledge is usually most incomplete.

From the botanical aspect it is unfortunate that the nomenclature does not always conform with modern practice, but as this work is published posthumously it is understandable that some errors are bound to occur. The editor, who is keeper of the Egyptian and Assyrian Department of the British Museum, explains that it was impossible to re-verify the large number of references consulted by the author, and his apology may be taken to include the vexed question of botanical synonymy.

The general contents are classified under arbitrary headings, with chapters or sections on such subjects as grasses, rushes and weeds, alkalis and soapworts, vegetables, vetches and cereals, flax, poisonous plants, dye plants, thorny plants, the 'hot' plants, narcotics, gums and resins, and miscellaneous uncertain plants.

As is to be expected in the botany of an old civilization, most of the plants mentioned are of some economic value; but although the majority are species of obvious utility as food-plants, materia medica, etc., the field covered is wide and the wealth of varied information presented justifies the comprehensive title of the book. Historical references predominate, but modern usage is not neglected, and some personal experiences of the author are included. The philological scope of the work may best be indicated by an enumeration of its indexes. Of these, the most important are Sumerian, Akkadian, Arabic, Latin and Greek, Aramaic and Syriac and Hebrew; with briefer references to Persian, Phoenician, Ras Shamra, Sanskrit, 'Indian', Egyptian, Hittite and other dialects. S. G. HARRISON

Profile of Science

By Ritchie Calder. Pp. 326. (London: George Allen and Unwin, Ltd., 1951.) 16*s*. net.

SETTING out unashamedly to interest those who would not touch a 'scientific' book, Ritchie Calder must be congratulated on the adventurous nature of his approach. He is aware that most people are interested in the biographical details of famous men and uses this as the way to introduce the four main subjects of the atom, radar, penicillin and vitamins. Each topic is complete in itself, and is portrayed in relation to its general scientific background; the story of penicillin, for example, is cunningly interspersed with accounts of the invention of the microscope, the discovery of germs and chemical therapeutics as well as up-to-date information about more recent investigations with antibiotics like streptomycin, chloromycetin and aureomycin. In his efforts to maintain the attention of even the most casual reader, Calder uses imagery which is nearly always successful in illuminating and focusing the point at issue. Perhaps the only criticism that can be made of his excellent impressionistic book is that occasionally the popular style becomes a little too 'hail-fellow-well-met' for those with more retiring natures.

Stand and Stare

By Walter J. C. Murray and L. Hugh Newman. Pp. 104 (31 plates). (London: Staples Press, Ltd., 1950.) 7*s*. 6*d*. net.

THIS collection of essays is a pleasant book on natural history topics which the authors, W. J. C. Murray and L. H. Newman, have aptly entitled "Stand and Stare", a phrase from W. H. Davies's poem on "Leisure", beginning:

> "What is this life if, full of care,
> We have no time to stand and stare?"

The authors tell most charmingly of many things at which it is well worth while to stand and stare, from tracks in the snow and on through fourteen chapters that deal with a variety of topics, including one on the British orchids. They point out that British orchids, if comparatively plain plants by the standard of many fantastically beautiful foreign species, are nevertheless of great interest, from their remarkable contrivances for effecting fertilization to their need of a mycelium in the soil before they can flourish.

Spiders, grasshoppers, butterflies, the mole, various fungi, snails and the flowers of trees are among the subjects discussed, all in a way likely to interest and help the novice. This book will solve the gift problem for many a parent or other relative who may be in difficulty over the question what to give the young person of open-air tastes. FRANCES PITT

FIFTH CENTENARY OF THE UNIVERSITY OF GLASGOW

By Prof. J. W. COOK, F.R.S.

To mark the five hundredth birthday of the University of Glasgow, a series of celebrations is being held in this Festival year. Already the students have commemorated the anniversary in their own characteristic way, the outstanding feature being the carrying of a lighted torch from the Border village of Bedrule, the birthplace of the founder, Bishop Turnbull, to Glasgow Cathedral, followed by a torchlight procession of some two thousand students through the city to the floodlit University. During the past winter session, a series of sixteen commemoration lectures on the history of the various academic disciplines in the University has been given by a like number of Glasgow professors, and will be published together in a special volume. The official celebrations, attended by delegates from universities and academies throughout the world, will take place during the coming week. An oration will be delivered by Lord Macmillan, and honorary degrees will be conferred on some seventy well-known men and women.

The University had its origin in a Bull of January 7, 1451, obtained from Pope Nicholas V, at the instance of James II of Scotland, by William Turnbull, Bishop of Glasgow. The new University was probably intended as a sister establishment to Bishop Kennedy's College at St. Andrews University, founded in 1412. In the preamble to the Bull the choice of Glasgow is explained: "the air is mild, victuals are plentiful, and great store of other things pertaining to the use of man is found". The University of Glasgow is thus senior to all British universities other than Oxford and Cambridge in England, and St. Andrews in Scotland. By the original constitution the Bishop of Glasgow was chancellor, the functional head being the elected rector. In some senses this latter tradition is still preserved in all four Scottish universities, the rector, elected by the students, being chairman of the University Court, the body which manages the property and finances of the University. For some centuries the only faculty in the University of Glasgow was the Faculty of Arts, and at first lectures and meetings were held in ecclesiastical buildings, usually in the Chapter House of the Cathedral. In due course the faculty occupied rented buildings, then it acquired its own land, and in the seventeenth century the very attractive old College of Glasgow was built. Its fine buildings, characteristic of Scots baronial architecture at its best, served for upwards of two hundred years. In 1870 the University was transferred to its present site on Gilmorehill, in the West End of Glasgow, and the old College buildings in the High Street were supplanted by a railway goods station.

In the space of this short article it is impossible to trace the various stages by which the University has developed from its small beginnings five hundred years ago to a large modern academic institution with nearly seven thousand students and a teaching staff of nearly six hundred. It must suffice to mention some of the more salient features and to refer to some of the developments which are now taking place.

In the earliest years of the University, the students were instructed by three 'regents' who expounded grammar, logic and philosophy and exercised discipline over all in the College. The essentials of this system were preserved in the remodelled constitution of 1577. The three regents became specialist teachers of Greek, logic and physics; the principal taught divinity and Hebrew. A fourth regency was added in 1581, and between 1637 and 1642, chairs of humanity, medicine and divinity were established. After the Restoration of 1660, the University suffered pecuniary difficulties and by 1677 the staff had been reduced to the principal, one professor (of divinity) and four regents. By the beginning of the eighteenth century the finances were again sound and expansion was resumed.

In 1704 a botanic garden was set up and a surgeon, John Marshall, was appointed to take charge of it and to lecture on botany. Later, teaching of botany became combined with that of anatomy, and in 1720 Thomas Brisbane was appointed professor of anatomy and botany, a combination which persisted until the foundation of the regius chair of botany in 1818. In the meantime, by 1720 eight new chairs had been added to the existing chair of divinity (including chairs of mathematics and medicine). Shortly afterwards, the three regencies were transformed into chairs of logic, moral philosophy and natural philosophy, and the thirteenth chair, in astronomy, was founded in 1760. Houses were provided for the incumbents of these thirteen chairs, and for the principal; the University Court has recently reaffirmed its intention to continue to make this provision for the holders of these earliest chairs.

The foundation of new regius chairs in the nineteenth century gave rise to friction, as the holders of the earlier chairs contended that they still retained control of the property and that the new regius professors were members of the Senate but not of the Faculty. These difficulties were only resolved by the new constitution of 1858. The Act of that year, supplemented by a further Act in 1889, gave the constitution under which the University is now governed.

Although a chair of medicine was established in 1637, it later lapsed and was revived in 1712. Even then it languished, and the Glasgow Medical School may be considered to have been founded by William Cullen, who became professor of medicine in 1751, and his pupil Joseph Black. These were also the first two lecturers in chemistry. They lived in a great period in Scottish cultural life. It was in 1751 also that Adam Smith became professor of logic, and a year later he was appointed to the chair of moral philosophy. James Watt was a pupil of Black. While still a young man of twenty-two he became "mathematical instrument-maker to the University". In the nineteenth century also, the roll of Glasgow professors contains many illustrious names, including those of Lord Lister, Lord Kelvin, Sir Richard Gibb, Edward Caird and Sir William Gairdner. As the nineteenth century merges into the present one, we find the names of Gilbert Murray, Sir William Macewen and Sir Robert Muir. To the present century itself belong Noël Paton (under whom the present chancellor, Lord Boyd-Orr, was a student demonstrator), Lord Lindsay, Sir John Graham Kerr, Sir Oliver Franks, E. P. Cathcart, Edward Hindle and Sir

Arthur Trueman. All save one of these twentieth-century former professors are happily still living and active. The Glasgow professor has never lacked distinguished pupils, and the roll of graduates, whose present number amounts to some 27,000 men and women, contains many illustrious and honoured names.

When the University moved to Gilmorehill in 1870, there were twenty-five professors. By 1900 six more chairs had been added, and during the present century the total number has risen to sixty-three. Additions to the buildings have steadily been made. The original buildings of 1870 contained very little laboratory accommodation, although there was a chemistry laboratory, still in use, octagonal in shape like laboratories at Oxford and Durham, and like them modelled on the kitchen of Glastonbury Abbey. By the end of the first decade of the present century there were new buildings for engineering, botany, natural philosophy and a building for some of the medical subjects. Temporary extensions to the chemistry laboratory had also been erected, and by 1924 there had been added a very massive new building for zoology. In 1939 a new observatory was opened, and in 1940 the first two blocks of a fine large new building for chemistry were completed; the third block is now under construction, as is also an extension of the natural philosophy building. This new extension will house a 300-million volts synchrotron, now being installed, for researches in nuclear physics under Prof. P. I. Dee. When the new chemistry building is complete, the evacuation of the old temporary laboratories will enable a start to be made with large extensions to the engineering laboratories. Other building operations are in progress, such as the construction of a new boiler house; alterations and extensions have been made to existing departments, including botany, mathematics, biochemistry and physiology, and zoology, in order to meet the needs of the modern University, and a new Department of Genetics has been established, under Dr. G. Pontecorvo. A comprehensive plan for the future development of the University is being prepared by Sir Frank Mears.

Other important changes have been taking place. In 1796 "Anderson's Institution" was founded as the result of a bequest by a dissenting professor of natural philosophy, John Anderson. This has grown into the present Royal Technical College, which is affiliated to the University for the purpose of certain degrees in applied science. An offshoot of Anderson's Institution became the Anderson College of Medicine. This, together with St. Mungo's College, established at the Royal Infirmary after the University moved from its vicinity in 1870, was amalgamated in 1947 with the University, which is now responsible for the teaching of all medical students in Glasgow. In the following year the Dental School was taken over, and in 1949 the Glasgow Veterinary College, so that the University now makes provision for education in dentistry and veterinary medicine. New relationships with the West of Scotland Agricultural College are also being developed, and the University will assume a much larger measure of responsibility for the degree courses in agriculture, the later stages of which hitherto have been conducted by the College. All these changes, coming immediately after the post-war expansion of student-numbers, have placed a considerable burden on the academic and administrative staffs. The University has also acquired the Garscube estate, a large site on the north-west outskirts of Glasgow, and here a start has been made with the erection of a building for an animal hospital and some of the veterinary departments. When conditions permit, it is planned to build a students' hostel on part of the Garscube estate.

Many of these new developments will take some years to consolidate; but it is evident that the University enters its sixth century in a state of healthy vigour.

CRYSTALLOGRAPHY IN MODERN SCIENCE*

Crystallography in Physics

THE science of crystallography is nowadays essentially the study of crystals by the diffraction or ordered scattering of X-rays, which itself may be regarded as a branch of optics. In the first place, scattering phenomena gave information about the nature of X-rays, then about the mechanism of interaction between X-rays or particles and matter, and at the same time about the structure of matter itself in relation to its physical properties. Some properties of matter such as hardness, tensile strength and elastic limit vary from one specimen to another of the same crystalline material, depending upon the size of the constituent crystals, their mutual arrangement and state of strain. These involve measurements generally beyond the resolving power of a microscope, and so the metallurgist and even the glaciologist have already had considerable assistance from the crystallographer. In trying to explain the so-called structure-sensitive properties of metals and ice, not only has the physicist developed techniques of ever-increasing certainty and accuracy in locating the positions of atoms and molecules in substances, but also it has been possible to find evidence of the thermal vibrations of the constituent particles of a crystal. Relatively soft organic substances and the metals sodium, lithium and lead show large atomic vibrations, whereas under the same conditions of temperature and pressure the vibrations in diamond and tungsten are much smaller. Moreover, these thermal vibrations vary for different directions in a crystal of a given substance and lead to different coefficients of thermal expansion.

The optical, electrical, magnetic and elastic properties of a crystal may also vary in different directions. Four examples recently studied serve as illustrations. (1) Ferro-electric crystals show big directional changes, for example, in piezo-electricity at certain temperatures, although these are apparently accompanied only by second-order crystallographic transformations. A satisfactory explanation is not yet available. (2) Elasticity depends upon atomic forces and can now be studied by means of the X-ray patterns given by the thermal waves in crystals. (3) Diamagnetic anisotropy is internally related both to the crystal structure of a substance and to the nature of the electronic orbits in the atoms or molecules. Its investigation can provide evidence for the existence of molecular orbitals in aromatic molecules. (4) Ferromagnetism and anti-ferromagnetism are

* Based on a course of four lectures at the Royal Institution on the applications and relationship of crystallography to physics, geology, biology and chemistry given respectively by Prof. Kathleen Lonsdale, F.R.S., Dr. F. A. Bannister, Dr. Dorothy Hodgkin, F.R.S., and Prof. J. Monteath Robertson, F.R.S., during October 31–November 21, 1950.

dependent upon co-operative interaction between spin movements of atoms having an incomplete 3*d* (or 4*f*) shell. Recent experiments at Oak Ridge in the United States have shown that both these phenomena can be studied by means of neutron diffraction methods, the magnetic scattering of neutrons being comparable in intensity with their scattering by nuclei. The 'magnetic lattice' in antiferromagnetics may be a superlattice of the ordinary crystallographic lattice, and X-ray measurements have shown a second-order diminution of symmetry in such crystals.

Crystallography in Geology

The rocks in the earth's crust consist of aggregates of one or more solid minerals, usually crystalline, although the outline of individual crystals seen in a fractured or polished surface may lack geometrical form owing to lack of freedom during growth. Rocks exhibit a wide variety of crystal size and texture, which can be studied in greater detail now that to the use of polarized light can be added X-ray diffraction techniques. It was realized long before the discovery of the diffraction of X-rays by crystals that the faces of a crystal are the boundaries of a regular arrangement of atoms or molecules. Only an internal regularity of structure could account for their cleavage, optical and other directional properties. The nature of the internal structure of solid matter was not proved nor physical measurements of the atomic positions possible until W. H. and W. L. Bragg applied von Laue's discovery to inorganic compounds and minerals. The more difficult mineral structures, particularly those of the silicates, were investigated after 1918, chiefly in Sir Lawrence Bragg's laboratory in Manchester. X-ray analysis has yielded up to now the crystal structures of nearly all the common minerals and of representatives of most of the well-known mineral families (about five hundred). There remain, however, more than three times that number, the crystal structure of which is uncertain or unknown. The geologist would also welcome detailed crystal structure analyses of inorganic substances that have been prepared in the laboratory and are close to, but not always identical with, the corresponding mineral.

The crystal structures of most inorganic solids, including minerals, are three-dimensional patterns of charged atoms. The molecule, that is, the group of atoms that corresponds to the chemical formula of the mineral, cannot be recognized as a unit of the crystal structure. The ionic structures characteristic of mineral chemistry consist of groups of large negatively charged ions like oxygen surrounding as closely as possible a small positively charged metal ion. The relative sizes of the ions, as well as their valency or charge, control the shape of the ionic group and so influence the crystal structure and the external crystal form. For example, the crystal structures of quartz, cristobalite, tridymite and all the silicates contain not molecules of SiO_2 but tetrahedral groups of four oxygen ions surrounding each silicon atom. In olivine, garnet and topaz the independent SiO_4 groups are linked up to ions of magnesium, iron, etc., and the structure must be electrically neutral not only as a whole but also locally throughout. The SiO_4 tetrahedra are linked into chains and bands in the pyroxenes and amphiboles, into hexagonal rings in beryl, and into continuous sheets of hexagonal rings in the micas, chlorites and most of the clay minerals.

To geologists the outstanding features of this advance in the knowledge of the solid state are twofold: the relative importance and size of the oxygen ion in minerals making up the greater part of the earth's crust; and the function of ionic size as well as charge in the replacement of one atom by another in a mineral (solid solution is neither an intimate admixture of two substances nor is it any longer possible to regard it as concerned with molecular solution in the solid state). Ionic substitution is typical of natural minerals, and, whether it occurred at the birth of a mineral or afterwards by alteration, it accounts for the long list of elements reported in many mineral analyses. Frequently this complexity of composition, which is illustrated so well in tourmaline and mica, distinguishes them also in structural detail and physical properties from their artificially prepared analogues.

Both single-crystal and powder techniques have become invaluable for the identification of all solid materials. They are non-destructive and use so small a quantity of mineral powder or crystal for determination that they frequently provide the only certain and speedy method of identifying a rare or precious mineral.

The quantitative estimation of two minerals in a mixture can sometimes be attained by using an internal standard of comparison like fluorite. Further studies on these lines are worth while if only to aid the petrologist and mining geologist in his quantitative estimation of the minerals present in a fine-grained rock and to provide an alternative technique for checking both petrological and chemical methods. A useful collection of powder data of minerals and other solid inorganic and organic substances is published in the now well known indexes of the American Society of Testing Materials. A keysort card index, recently provided for the Department of Mineralogy of the British Museum (Natural History) by the Institute of Physics, is now being prepared for speeding up mineral identifications using the X-ray powder method.

Crystallography in Biology

Biological materials are of such complexity that it is not surprising that crystallography can only make a rather limited, even if important, contribution in this field. Few materials occur actually crystalline in plant tissues; except perhaps in the case of certain plant storage proteins, crystals appear only as the result of some abnormality, for example, cholesterol in ovarian tissues and tobacco mosaic virus in plant cells. But crystallography, as a study of structures ordered in three dimensions, leads one naturally to consider systems which show various types of regularity in two or one dimensions. To detect order, tools can be used, such as optical microscopy, X-ray diffraction and the electron microscope, preferably all combined; and the amount of information one can extract varies with the degree of order that can be observed; for example, cellulose fibres give detailed diffraction patterns from which approximate positions of the atoms in the cellulose chains can be found, and the orientation of the chains in plant cell walls can be traced out. Lipids give diffraction patterns characteristic of long-chain compounds forming double layers; by studying their behaviour in different solutions, it is possible to deduce that the lipid molecules are probably arranged in layers which are interleaved by protein layers, in the myelin sheaths of nerves.

Proteins themselves, fibrous and globular, provide a variety of kinds of structure. Except in the case of silk fibroin, the fibre diffraction patterns do not give enough detail to permit the deduction of atomic positions, though it is clear that the arrangement found, of extended peptide chains, is that of the β-keratin type of fibre in general. The α-keratin and collagen wide-angle diffraction patterns indicate folded peptide chains of some kind, but in a number of naturally occurring systems—for example, muscle and collagen fibres—there is evidence of a much larger scale structure superimposed on the peptide chain pattern. This large-scale structure is confirmed by electron microscope pictures. Collagen fibrils show a complex system of bands with a repeat unit of about 640 A.; muscle fibrils appear to consist of particles some 300 A. long and 100 A. across, while the fibrils themselves are packed in a roughly hexagonal array. In the case of the tobacco mosaic virus, one can observe the behaviour of separated large molecular units some 2,000–3,000 A. long and 150 A. across, which assume various degrees of ordered arrangement in solution and in crystals. Here the molecules are so large that their arrangement in layers in the crystal can be observed in polarized light, while the wide-angle X-ray diffraction pattern of the molecules in solution shows considerable complexity due almost entirely to their internal structure.

In protein crystals there is a regular array of large molecules, often separated by layers of water of crystallization. Although their X-ray diffraction patterns provide a wealth of data, it is difficult at present to do more than estimate roughly the molecular shape and the possible peptide chain directions within each molecule. It is interesting that the distribution of haemoglobin molecules in the red blood cell corresponds to an approximately close-packed array of freely rotating molecules of the shape indicated by the crystal measurements. Their concentration in the red cell is the greatest which is consistent with random orientation of the haem groups and consequent easy availability to oxygen, and recently Dr. M. F. Perutz has shown that the change in solubility of the reduced hæmoglobin of patients suffering from sickle-cell anæmia leads to actual crystallization in the cells themselves and hence to distortion of their shape.

In all biological systems, great interest is aroused by the problem of the short-range interaction of different types of active molecule—for example, in enzyme reactions. Here it is probable that the detailed solution of the crystal structures of some of the active molecules may prove very informative. Already, detailed X-ray analyses have been carried out for individuals of most of the important types—amino-acids, sugars, sterols, purines, pyrimidines, and one ribose nucleoside—and it is possible to estimate, in these structures, the part played by shape and inter-molecular forces. Still more important may be the evidence which can be provided by structures such as that of vitamin B_{12}, where a number of different active groups are known to be combined within one molecule.

Crystallography in Chemistry

Since 1912, when von Laue and the Braggs discovered the diffraction of X-rays by crystals, crystallography has become more than ever before essential to chemistry. The remarkable advances which followed John Dalton's atomic theory culminated in the discovery of the rules governing the arrangement of the atoms in carbon compounds, so that before the end of the nineteenth century structural formulæ had been determined for a very great number of organic substances in which the molecule has a well-defined existence. The exact composition of many inorganic compounds was also known, but, unlike organic compounds, they often have high melting points and do not yield vapours without decomposition. Consequently, the number of atoms in the 'molecule' was often open to doubt, and little or nothing could be guessed about the spatial arrangement of the atoms. The diffraction of X-rays by crystals provided the information, and moreover revealed that the molecule has no individual existence in the majority of inorganic substances. Although considerable progress has been made in the determination of crystal structures of minerals, including the silicates and related materials, there remain many complex inorganic compounds, for example, heteropoly acids and their salts, the structures of which still await elucidation by the X-ray method.

Progress for organic compounds, however, has been relatively slow. It is only within about the past twenty years that the methods of X-ray analysis have become sufficiently refined to examine the structure of organic crystals in real detail and to determine the positions of all the atoms. The results obtained, which are now quite numerous and cover many hundreds of different structures, serve in the first place to confirm the formulæ of the organic chemist. The organic chemist already knows the *relative* spatial positions of all the atoms in many hundreds of thousands of different compounds; all this has been achieved by means of a perfectly precise and yet non-mathematical logic which is one of the wonders of modern science. So far, all these formulæ have been completely confirmed by the X-ray method, which, however, adds a great deal to what is already known.

The method of X-ray analysis translates the structural formulæ of the chemist into exact metrical terms, and enables him to measure quantitatively the bond-lengths, valency-angles and the general electron distribution in the molecule. These data all lie beyond the scope of ordinary chemical methods, but they are of the utmost importance in providing the necessary connecting link with general theoretical developments. An example is the very large hydrocarbon molecule, ovalene, $C_{32}H_{14}$.

The X-ray method provides equally precise information about the way the organic molecules are linked together in the solid state. For example, the intermolecular distance between six molecules of ovalene, controlled only by Van der Waals forces, can be measured with the same certainty as the distances within the molecules. The situation is altered when the molecules of a compound contain hydroxylic or phenolic oxygen or groups containing an easily replaceable hydrogen atom.

An organic compound like α-resorcinol has an open structure, although hydrogen bonds tie certain parts of the molecule closely together. These bonds are directive, and when the substance is heated it does not melt; but the hydrogen bonds 'melt' sufficiently to allow the open structure to collapse to a more dense form, which is stable at a higher temperature. X-ray analysis has explained the reason for this transition.

The gradual improvement of the X-ray method of analysis now makes it possible to attempt to elucidate the structure of molecules which are so complicated that they have not so far yielded to the ordinary methods of chemistry. It is not yet possible to measure directly the relative phase relationships of the X-ray reflexions. This is the fundamental difficulty of X-ray analysis. While the amplitudes of the waves of electron density can be measured, these can be combined by the Fourier method only if their relative phase factors have been correctly chosen. By introducing a heavy atom at a known point in the structure, it is possible to convert these unknown differences in phase to differences in amplitude which can be measured. This method, and some of its modifications, was first extensively used in the determination of the phthalocyanine structures. A comparatively simple structure which has just been determined in this way is the copper salt of the newly discovered aromatic compound tropolone. By far the most striking example of work in this field, however, is the analysis of the penicillin structure which was carried out by Dr. Dorothy Hodgkin during the Second World War. This work advanced hand-in-hand with the purely chemical investigation of the structure, and this is undoubtedly the best way to proceed with such unknown and complex structures.

The whole subject of crystallography has now so grown that it really has the dimensions of a separate science in its own right. The division of knowledge into separate sciences is, of course, purely a matter of convenience. One of the most important aspects of X-ray crystal analysis is that it serves to unite the various sciences into one. In addition, the new science is rapidly bridging the much wider gap between biology and physics, and between biology and chemistry.

F. A. Bannister

THE ROYAL ACADEMY, 1951

By Dr. A. TINDELL HOPWOOD

SHORTLY before the opening of this year's Royal Academy exhibition, the Arts Council bought four pictures by living painters. One picture was reproduced in the daily Press and a lively correspondence ensued. The points at issue were two, namely, was the painting a work of art and, depending on the answer to that question, had public money been wasted or not? The details of the dispute do not matter: the chief point of interest was that the contestants never properly came to grips, apparently because each side failed to understand the arguments of the other. This failure to understand is no new thing; it occurs over and over again in the history of art, but at no time has the problem been so acute as it is to-day. In part it arises from genuine differences of approach; but in part it would seem that jargon serves as a cloak for muddled thinking—a phenomenon not entirely unknown in scientific circles.

To judge by the writings of some of their prophets, the primary duty of 'modern' artists is to express themselves: freedom of expression is the watchword. Maybe that is true, and maybe in a properly ordered world the struggles of an artist to bring his ideas to birth would be watched with sympathy and understanding, and the ideas themselves received with the honour that the artist feels to be their due. It might be so; but I doubt it. For one thing, the argument seems to rest upon false premises, not the least of them being that it is somehow incumbent upon an observer to be interested in the things submitted for his inspection, an assumption so mistaken that it destroys all the rest of the argument.

Suppose for a moment that it is the observer's duty to be interested in what the artist produces, then it becomes the artist's duty to produce in such a way that he interests the observer; but in so doing the artist limits his freedom of expression, because he must of necessity produce something within the comprehension of those whom he seeks to interest. If he produces something transcending the comprehension of the beholder, he may not complain of lack of interest: one cannot take a rational interest in things beyond one's comprehension. Interest depends on importance, and, in the affairs of the mind at any rate, importance is largely dependent on comprehension. Consequently, failure of the artist in his reciprocal duty to the observer releases the latter from his supposed duty to the artist, and contact between the two is lost.

When that happens, the artist or, more often, a self-appointed interpreter, is apt to seize the pen in an endeavour to defend and explain his art. Immediately jargon begins to rear its ugly head, and not unnaturally. Art is essentially an interpretation of spiritual experience; for that reason rational explanations are extremely difficult to express in ordinary language. The more intense the experience, the greater the difficulty of expression becomes: hence the temptation to use jargon. But, broadly speaking, there are two types of jargon; one is little more than technicalities easily understood by anyone willing to make the mental effort involved in an endeavour to obtain an insight into an unfamiliar subject. The other type is far different; its terms are often meaningless because those who employ them have not taken the trouble to endow them with meaning. Themselves lacking the discipline of mind that is a prerequisite of civilized achievement, they are hurt and frustrated to find themselves misunderstood or ignored. When a disciplined mind is brought to bear on the same problems, everything becomes different.

One of the charges most often brought against 'modern' art is that it is unnatural in the sense that it wilfully distorts the human figure. Stanley Spencer, for example, has wilfully distorted the human form in "Sausage Shop" and "Christ shown to the People"; but the fact that the figures are distorted need not, or should not, lay him open to accusations of sensationalism or insincerity. On this point the neo-Thomist Maritain is clear and unambiguous: "If the 'distortions' due to the vision or the conception of the artist impose themselves upon him . . . with a sincere and as it were instinctive spontaneity, there may then be others depending upon the *means* of art, and these are deliberate and calculated. Many instances are to be found in the masters . . . of such . . . distortions, abbreviations and redispositions, all consciously effected." Elsewhere he has remarked that he does not object to a painter giving a woman half an eye, providing he can be satisfied that it is necessary for her to have but half an eye. In thus defending one of the more controversial aspects

of modernity, the trained mind has no need of jargon.

The two pictures just mentioned, however, have no scientific interest if science is taken to have its common meaning, and by long tradition successive authors of these reviews have made some attempt, however slight, to discover at least a few works that might be expected to interest those whose training has been in the rigid materialism of the sciences, as well as those whose lot has been cast in the warmer and more generous atmosphere of the humanities. First of all, then, "Embryonic Kitten—grain study in coarse pine" may arouse the curiosity of the botanist and, no doubt, the wrath of the embryologist; but surely none can fail to be amused by "Caterpillar", an ivory statuette of a sphingid larva standing on its 'hind legs'. Indeed, the sculpture this year is noteworthy for the high proportion of animal studies, all more or less stylized and none without a certain charm.

Leaving the flower pieces—fewer in number than usual—on one side, probably one of the most interesting pictures, scientifically, is "Sixteen-year-old Suffolk Stallion" by Sir Alfred Munnings. The old 'Punch', hollow-backed, is seen standing in his stable in such a way that the great depth of the neck at the junction with the body is clearly visible. This feature causes the neck to be more markedly subtriangular than it is in other heavy breeds and may account for the head appearing to be disproportionately small. Moreover, it suggests inquiry into the history of the Suffolk Punch and makes one hazard a guess that the breed may be descended from the horses painted by Vandyck and others that I discussed on a previous occasion (*Nature*, **158**, 695; 1946).

Geologists seldom have an opportunity of seeing how their classical localities appear to a painter, and for that reason, if for no other, "Malham Cove" by Richard Eurich is worthy of consideration; needless to say, it is very well painted, although the heavy cloud-shadow in the top right-hand corner may cause some trouble until it is realized that pictorially it is an essential feature.

Taken as a whole, one would hesitate to describe this year's Royal Academy exhibition as more than mediocre. On the other hand, one would not subscribe to the cynical opinion that every Academy is 'the worst ever'—until the next one comes along. In each room there are up to half a dozen works of high merit, and if here and there it is obvious that the Hanging Committee made an unhappy choice, it should be remembered in extenuation of their shortcoming that more than ten thousand works were submitted for their inspection, and what that means only they can say.

OBITUARY

Mr. Thomas Henry Court

Thomas Henry Court, who died at Harrow on April 19, contributed much to museums and collections of scientific instruments throughout Great Britain. He was a retiring man, known to a comparatively small circle of friends; but his genius for searching out and collecting old instruments, particularly microscopes, has made him an outstanding figure in the development of our knowledge of the history of scientific instruments.

All those who have carefully examined the wonderful collection of instruments on the top floor of the Science Museum at South Kensington must have been struck by the very large number of labels on which is written "Presented by Thomas H. Court, Esq.", and may have wondered who was this most generous benefactor and how could he have amassed, and presented for the benefit of the general public, such a collection of valuable instruments.

Thomas Court had only a brief grammar school education at Ongar, and spent his early years working in various ways, including tailoring and assisting his uncle as an insurance agent. Finally, he joined the piano firm of Brinsmead of Camden Town about 1895, as collector of outstanding payments on the then newly developed hire-purchase system. One day by chance he attended Stevens's Auction Rooms in Covent Garden, and bought a miscellaneous lot which included an old microscope. This he sold at a good profit, and conceived the idea of buying old microscopes and other instruments while on his travels as a debt collector in different parts of the country. He became so interested that he made a thorough study of the subject and gradually acquired a very sound knowledge, especially of the older instruments. He had a marvellous memory and a flair for noticing any special feature of construction. While still employed by Brinsmead, he took some antique microscopes to Mr. Baxendall, of the staff of the Science Museum, who gave him much help on the historical aspect; and it was as a result of this association that Mr. Court arranged to deposit many of his microscopes and other instruments in the Science Museum.

At that period there were few scientific instruments in the Museum, and Mr. Court decided to seek out and assemble a representative collection to be presented to the Science Museum, which he did at intervals from 1911 until 1949, the greatest gift being in 1928; this last donation included many instruments from the famous collection of Sir Frank Crisp. The Crisp collection was sold in 1925, when Mr. Court bought most of the rarer microscopes, including Hooke's own microscope made by Cock, and examples of most of the famous makers such as Marshall, Culpeper, Martin and Adams. In his later years, Mr. Court spent many days at the British Museum tracing dates and particulars of makers from old directories, documents and letters. He was a well-known frequenter of sales and auctions, where he and his daughter bought also many old and valuable books dealing with instruments. As many of these were in Latin, he taught himself sufficient of this language to read them—no small achievement for a man then over sixty. His best-known publication is "The History of the Microscope", written in conjunction with Dr. R. S. Clay; but they also contributed a number of papers to the Royal Microscopical Society. Mrs. Court died in 1930; but he leaves two daughters who are generously carrying out his wish that the Science Museum should receive any further instruments desired from his remaining collection.

Such is the brief account of the life of a man who, starting without scientific training and from a humble beginning, has by his own efforts and farsightedness provided for the benefit of generations to come a collection of scientific instruments which is unsurpassed in the world and which is unique as an illustration of the historical development of the science of optics.

NEWS and VIEWS

King's Birthday Honours

The following names of men of science and others associated with scientific work appear in the King's Birthday honours list:

K.C.B.: Dr. Thomas D. Kendrick, director and principal librarian, British Museum; Sir Edwin Plowden, chief planning officer, H.M. Treasury.

K.C.M.G.: Mr. Geoffrey F. Clay, agricultural adviser to the Secretary of State for the Colonies.

K.B.E.: Mr. Hamish D. MacLaren, director of electrical engineering, Admiralty; Dr. William K. Slater, secretary, Agricultural Research Council.

D.B.E.: Prof. Hilda N. Lloyd, president of the Royal College of Obstetricians and Gynæcologists; Prof. Lillian M. Penson, vice-chancellor of the University of London.

Knights: Mr. Roger Duncalfe, chairman of the British Standards Institution; Prof. Charles A. Lovatt Evans, emeritus professor of physiology, University of London; Dr. Ernest F. Finch, for services to surgery and medical education; Prof. John W. McNee, regius professor of medicine, University of Glasgow; Prof. Eric K. Rideal, professor of chemistry, King's College, London, president of the Chemical Society; Dr. Henry W. H. Warren, managing director, Associated Electrical Industries, Ltd.

C.B.: Mr. T. E. Harris, chief superintendent, Royal Ordnance Factory, Woolwich; Dr. W. Thomas, chief inspector for Wales, Ministry of Education; Mr. H. E. Watts, H.M. chief inspector of explosives, Home Office.

C.M.G.: Mr. H. A. Gill, chartered patent agent, for services at international conferences on industrial property; Dr. J. W. Field, director of the Institute for Medical Research, Federation of Malaya.

C.B.E.: Dr. W. R. G. Atkins, head of the Department of General Physiology, Plymouth Laboratory, Marine Biological Association; Mr. H. R. Blanford, editor-secretary, Empire Forestry Association; Mr. H. Bradley, director of research, British Boot, Shoe and Allied Trades Research Association; Mr. W. K. Brasher, secretary, Institution of Electrical Engineers; Mr. A. Campbell, chief mechanical engineer, Office of the Crown Agents for the Colonies; Mr. H. T. Chapman, managing director, Armstrong-Siddeley Motors, Ltd., Coventry; Mr. W. H. Chatten, assistant director of dockyards, Admiralty; Prof. G. M. B. Dobson, reader in meteorology, University of Oxford; Mr. A. N. East, chief engineering inspector, Ministry of Fuel and Power; Mr. L. R. East, chairman of the State Rivers and Water Supply Commission, State of Victoria; Mr. E. I. Fawcett, director-general of agriculture, Department of Agriculture, New Zealand; Mr. G. W. H. Gardner, director of guided weapons research and development, Ministry of Supply; Mr. F. Y. Henderson, director, Forest Products Research Laboratory, Department of Scientific and Industrial Research; Mr. H. A. Hepburn, deputy chief inspector of factories, Ministry of Labour and National Service; Dr. A. B. Hill, consultant in medical statistics to the Royal Air Force; Mr. L. Howles, chairman, South Wales Electricity Board; Mr. A. H. Megaw, director of antiquities, Cyprus; Prof. J. S. Mitchell, professor of radiotherapeutics, University of Cambridge; Mr. W. E. W. Petter, deputy managing director, Folland Aircraft, Ltd., Hamble, Hampshire; Prof. B. E. Murphy, professor of economics, Victoria University College, New Zealand; Mr. O. J. Sangar, director of forestry for England, Forestry Commission; Mr. A. G. Strickland, chief horticulturist, Department of Agriculture, State of South Australia; Prof. J. M. Webster, director, West Midland Forensic Science Laboratory, Birmingham.

Research Laboratories of The General Electric Co., Ltd.: Mr. O. W. Humphreys

Mr. O. W. Humphreys, who has recently been appointed director of the Research Laboratories of The General Electric Co., Ltd., was born in 1902 and educated at Caterham School and University College, London. He graduated with honours in physics in 1925, and joined the scientific staff of the Research Laboratories of The General Electric Co., Ltd., in July of that year. Two years later, Mr. Humphreys was put in charge of the Heat Group; here he was responsible for research and development work associated with all forms of industrial and domestic heating, as well as their applications. During the Second World War, Mr. Humphreys was concerned with such specialized problems as the heating of guns on warships to fit them for Arctic service. He also studied the unique space-heating problems that arose in connexion with the installations of 'Fido' for fog dispersal on aerodromes. It was also during the war period that the late Sir Clifford Paterson (then director of the Laboratories) arranged for Mr. Humphreys to be closely associated with him in the administration of the Laboratories, in addition to his research activities. At this time the Laboratories, under the leadership of their founder director, were rapidly expanding to more than double their pre-war strength. Following the death of Sir Clifford in 1948, Mr. Humphreys was appointed manager of the Laboratories in February 1949. Under his leadership, the expansion of the research activities of The General Electric Co. has continued. The shortage of space in the main Laboratories has made necessary the opening of other establishments, two more in the Wembley area, in addition to the laboratories operated by the Company at Stanmore. The total staff now numbers more than two thousand and the annual expenditure exceeds £1½ millions per annum. Mr. Humphreys's many other activities include membership of the Councils of the British Electrical and Allied Industries Research Association and of the British Non-Ferrous Metals Research Association. He is on the Board of the Institute of Physics, a member of the Utilization Section Committee of the Institution of Electrical Engineers, and a manager of the Royal Institution. Mr. Humphreys serves on various committees of the British Standards Institution.

Hoblizelle National Award in Agricultural Sciences: Prof. C. E. Marshall

The Hoblizelle National Award in Agricultural Sciences has been made to Prof. C. E. Marshall, professor of soils in the University of Missouri. This Award, consisting of a gold medal and 5,000 dollars, was given by the Texas Research Foundation for research judged to be the greatest scientific contribution to American agriculture during 1948–50. A similar award was given to a Texas farmer who had, in the State of Texas, made the most successful application of scientific methods to practical farming in the same period. Prof. Marshall was born in

England and educated at the Manchester Grammar School and the University of Manchester. After graduating in chemistry, he did two years of research at Rothamsted, and then took his Ph.D. at London in 1927. Following a year of postdoctorate research at the Polytechnic Institute, Zurich, he was assistant lecturer in agricultural chemistry during 1928–36 in the University of Leeds, and then went to the University of Missouri, becoming professor of soils there in 1942. Prof. Marshall has been secretary and chairman of the Colloid Chemistry Division of the American Chemical Society, and has served as president of the Soil Science Society of America and chairman of the Soils Division of the American Society of Agronomy.

American Academy of Arts and Sciences

Dr. Edwin H. Land has been elected president of the American Academy of Arts and Sciences in succession to Dr. H. M. Jones, professor of English, Harvard University. Dr. Land is the founder, president and director of research of the Polaroid Corporation, Cambridge, Mass., and is an inventor of polarizers, the Land camera that delivers a finished photograph immediately after exposure, and other optical equipment. He received the 1945 Rumford Gold and Silver Medals awarded by the Academy for his contributions in polarized light and photography. Vice-presidents of the four Classes of the Academy have been elected as follows: *Class I* (*Mathematical and Physical Sciences*), Dr. Jerome C. Hunsaker, head of the Department of Aeronautical Engineering, Massachusetts Institute of Technology; *Class II* (*Natural and Physiological Sciences*), Prof. Alfred S. Romer, Alexander Agassiz professor of zoology, Harvard University; *Class III* (*Social Arts*), Erwin D. Canham, editor of the *Christian Science Monitor*; *Class IV* (*Humanities*), Wallace Goodrich, director emeritus, New England Conservatory of Music. The following have been elected foreign honorary members of the Academy: *Class I* (*Section 3, Chemistry*), Sir Cyril Hinshelwood, professor of chemistry, University of Oxford; *Class II* (*Section 2, Botany*), Prof. C. W. Wardlaw, professor of cryptogamic botany, University of Manchester; *Class II* (*Section 3, Zoology and Physiology*), Sir Charles Harington, director of the National Institute for Medical Research, London; *Class III* (*Section 2, Government, International Law and Diplomacy*), Charles Habib Malik, Lebanese Minister to the United States, U.N. Delegate, educationist; *Class IV* (*Section 2, History, Archæology and Anthropology*), Prof. H. E. Sigerist, formerly professor of the history of medicine, Johns Hopkins University, and now living in Switzerland. The total membership of the Academy now numbers nearly a thousand, which is the permissible limit.

A Century of Lighthouse Equipment: Chance Brothers, Ltd.

On June 6, a dinner held in London marked the centenary of the opening of the Lighthouse Works of Messrs. Chance Brothers. The firm began its existence in 1824, when Robert Lucas Chance acquired the works of the British Crown Glass Co. at Smethwick, and has continued there with members of the family at its head until the present day. Its history has been sketched in a well-illustrated brochure entitled "Mirror for Chance" recently issued. In 1839, James Timmins Chance, nephew of the founder, and a brilliant mathematician and scholar, joined the Company, and his interest and knowledge were responsible for the beginning of the firm's long association with navigation lighting. In 1851, Chance's first lighthouse optic was shown at the Great Exhibition, and now in 1951 another Chance 'light' flashes from the Shot Tower in the South Bank Exhibition. Incidentally, the Smethwick works provided the million square feet of glass required to glaze the 'Crystal Palace' itself. Now the firm manufactures a wide range of laboratory, optical and other glasses, while a map showing the distribution all over the world of navigation lights equipped by Chance Brothers during the past hundred years is an impressive tribute to its contribution to safety at sea.

Patent Office Library

Many readers will be interested to hear that arrangements have been made to keep the Patent Office Library open provisionally until 9 p.m. from Monday to Friday each week. Saturday closing remains at 5 p.m. Evening hours of opening should be specially valuable to those occupied elsewhere during the day and to visitors to London. This is our leading national technical reference library; until the First World War it was open from 10 a.m. until 10 p.m., had ample accommodation to give open access to its whole contents, and provided many useful bibliographical guides, of which the class lists of periodicals will be specially remembered. Owing to the effect of two wars these facilities had been greatly curtailed. The Library has been closed at 6 p.m. on Monday to Friday and at 5 p.m. on Saturdays; binding has been in arrears, with consequent restrictions of access to many periodicals; accessions have not kept pace with the large increase of publications and no recent bibliographies have been published. The prospect of an enlarged and modern Patent Office Library on a new site is therefore most encouraging; but in the meantime much might be done to restore the old standards of service, and make the whole contents of the Library more promptly available to readers.

Journal of the Franklin Institute: 125th Anniversary Issue

The January 1951 issue of the *Journal of the Franklin Institute* is a special commemorative issue to celebrate the 125th anniversary of the establishment of the *Journal* (pp. 208+xxxii; Philadelphia, Pa.: Franklin Institute, 1951; 1 dollar). In accordance with the policy enunciated in its original prospectus in 1825, the *Journal* has remained an unspecialized technical publication. Its object was "to diffuse information on every subject connected with useful arts", and the content of its volumes during the past century and a quarter reveals the great material progress that has been made during that period, the transition from hand crafts to factory production, and, in particular, the growth of specialization and the quickening tempo of progress in science and technology during the past fifty years.

The anniversary issue contains a short introductory article by T. Coulson outlining the history of the *Journal*, and then the remainder is devoted to "Science and Tomorrow", a group of fifteen papers describing possible and probable future developments in various branches of science and technology. The contributors are all leading authorities, and both students of science and laymen will find the contributions informative and interesting. In the first section, on the basic physical sciences, O. Struve

discusses astronomy; H. C. Urey, chemistry in the twentieth century; M. Morse, mathematics, under the title of "Trends in Analysis"; and I. I. Rabi, twentieth-century physics. The applied sciences and technology are dealt with in the second section, and aeronautics, communications, controlled mechanisms, electronics, materials, nutrition, standardization and transportation are discussed in separate articles. Two special articles, dealing with cosmic rays and solid-state physics respectively, follow; and the concluding paper by W. F. G. Swann, entitled "Science Today and Yesterday", though originally intended to be a summary of all the preceding papers, is, through no fault of the author, a meditation on the contrast between a similar symposium held, say, three hundred years ago, and the present one. The 125th anniversary issue of the *Journal of the Franklin Institute* proudly maintains the tradition and high standard of American science and industry, and of a professional journal in the pages of which original contributions by most renowned names have appeared.

International Exchange of Scientific and Technical Publications

Arrangements for the exchange of certain classes of government-sponsored scientific and technical literature, between the eighteen member-nations of the Organization for European Economic Co-operation, came into operation at the beginning of the year. Under this scheme, members deposit with one another up to six copies of publications on the following subjects: physical and biological sciences, in so far as the material is likely to be of direct or indirect interest to industry; any branch of technology; medical matters of industrial interest; and economic questions relating to industrial productivity, particularly statistical material. In the United Kingdom, the Technical Information and Documents Unit of the Department of Scientific and Industrial Research (at Lacon House, Theobalds Road, London, W.C.1) is the central clearing-house, and two copies of each publication are held there, one of which is for loan. Another two are distributed within London, among the Science Library, Patent Office Library, British Library of Political and Economic Science, and the Board of Trade Statistics Library, each of which receives material appropriate to its specialist activities. The remaining two copies go to the Science and Technology Library of Sheffield City Libraries, and to the Mitchell Library of Glasgow, which are repositories for the north of England and Scotland respectively, and under certain conditions the material can be borrowed from these two repositories. At present, eight of the eighteen member countries are contributing to the scheme, and the Board of Trade has distributed more than 350 items to each deposit library. Most of them are in the language of the country of origin, but a few are also in English. The material mainly consists of periodicals. Translated contents lists of each publication are at present distributed to all the repository libraries, and in accord with their special interests, to some of the larger firms, to trade and research associations, and other industrial bodies. As no general list of the periodicals received under the scheme has yet been published, Sheffield City Libraries have prepared stencilled lists of their holdings. The supply is limited; but a copy will be sent to any interested library or other organization, on application to the City Librarian, Central Library, Sheffield, 1.

Bibliography of Science in Latin America

To the series of bibliographies of Latin-American scientific activities (see *Nature*, April 23, p. 589, and December 23, p. 1059; 1950), which is published by Unesco Field Science Co-operation Office for Latin America, Montevideo, three further additions have been made, dealing with Mexico, Bolivia and Venezuela respectively. Each is volume 1 of a list of men of science and of scientific institutions in the three countries. Both lists are arranged alphabetically, that for men of science giving fairly comprehensive details of career and publications, and that for institutions outlining the scope of activities and containing information on staff and publications. The same Scientific Co-operation Office has also issued a "List of Scientific Papers published in Latin America during 1949". The papers are arranged under thirteen heads: general science; physics and astronomy; chemistry and biochemistry; geology, mineralogy, geophysics and meteorology; geography; palæontology and fossils; biology; botany; zoology; agricultural sciences; veterinary sciences; engineering; and medical sciences. The last is further subdivided under fourteen heads. The entries give the title and author of the article and the volume, part and pagination of the periodical, but not its name; for this last it is necessary to refer back to the numbered list of periodicals and serials, arranged under countries, with the address of the publisher. It is to be hoped that in future issues the inconvenience caused thereby to the reader or searcher will be avoided by adoption of the normal practice of standard abbreviations for the titles of periodicals such as are used in the "World List of Scientific Periodicals". The present list includes entries from Argentina, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Chile, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, Puerto Rico, Dominican Republic, Uruguay and Venezuela.

Anthropometry in Ruanda–Urundi (East Africa)

The indigenous Bantu-speaking inhabitants of the Belgian-administered Trusteeship Territory of Ruanda–Urundi, once part of German East Africa, comprise a tripartite social hierarchy, namely, the dominant pastoral Tutsi, the more numerous agricultural Hutu, and the exiguous pygmy Twa, who are hunters. In "Les Batutsi et les Bahutu" (*Mém. Inst. Roy. Sci. Nat. Belg.*, 2me sér., Fasc. 31; 1949; pp. 112+4 pl.), Dr. Georges Gerkens discusses the measurements of 214 Tutsi and 179 Hutu taken in 1935 by Prof. G. Smets during his expedition of that year. Of the total of 393 subjects, all male, 82 Tutsi and 70 Hutu came from Ruanda, and 132 Tutsi and 109 Hutu from Urundi. Seven characters—stature, sitting height, span, head length, head breadth, nasal height (from the *sellion* or most depressed part at the root of the nose and not the usual *nasion* or fronto-nasal suture) and nasal breadth—were originally recorded, and leg length and four customary indices have been computed from them. The material is exhaustively analysed, first as a whole and then on separate geographical and social bases, and the conclusion is reached that the Tutsi and the Hutu form anthropometrically distinct groups. The heterogeneity of the total sample and of the two geographical divisions is thus at least partly accounted for; although the doubtful inference is made that the differences be-

tween the social classes will disappear, perhaps in the near future. In addition to means, their probable errors, standard deviations and coefficients of variation, Dr. Gerkens provides individual values of the seven characters mentioned and several correlations. At times it seems likely that he is misled when he interprets the bimodality of a curve dependent on a small number of observations as necessarily indicative of a heterogeneous population. His data are far more extensive than those amassed by Czekanowski on the same two peoples early in the century, and they will add considerably to the knowledge of the racial situation in this little-studied area of Africa. In their presentation and statistical treatment, they maintain the standards of the native land of that pioneer anthropometrician, the great Quetelet.

Illuminating Engineering Society: Annual General Meeting

At the annual general meeting of the Illuminating Engineering Society which was held on May 8 at the Royal Institution, the president, L. J. Davies, presented the report of the Council for the year ending December 31, 1950. Among the points raised in the report was the decision to hold a summer meeting in Eastbourne in May 1952, on the lines of the Buxton meeting in 1950. Mr. Davies also referred to the "Register of Lighting Engineers" which has now been in operation for nearly three years; at the end of the year there were 212 names of members on the Register. At the meeting, officers and new members of council to take office in October were announced as follows: *President*, J. G. Holmes; *Honorary Treasurer*, W. J. Jones; *Honorary Secretary*, H. C. Weston (38 Victoria Street, London, S.W.1); *Honorary Editor*, Dr. W. E. Harper.

Honorary membership of the Society has been awarded to Dr. John W. T. Walsh, who is the only person to have been president of the Society twice, first in 1929 and again in 1947. Dr. Walsh has been for many years at the National Physical Laboratory, Teddington, where he is now a senior principal scientific officer in the Light Division; but his work has extended beyond the confines of the Laboratory; he was, for example, closely connected with the first large-scale lighting tests carried out in factories for the Departmental Committee on Factory Lighting when that Committee was first set up in 1913. He has, too, been concerned with street lighting during recent years and served on the Departmental Committee set up by the Ministry of Transport before the Second World War. Dr. Walsh is also well known outside Great Britain, particularly for his work with the International Commission on Illumination, of which he was made a vice-president in 1948. He was general secretary of the Commission during 1921–28, and then became honorary secretary until 1931 during the late Sir Clifford Paterson's presidency.

Tuatara

The journal *Tuatara* was founded three years ago by the biological society of Victoria University College, Wellington, New Zealand, to provide a medium for articles on biological research in New Zealand which would be readily accessible to the student and the general public. Since that time a series of articles on various aspects of the New Zealand fauna and flora have appeared as well as more general articles on biological principles and current biological practice. The most recent number, for example, contains accounts of trans-oceanic dispersal of plants to New Zealand and of New Zealand's terrestrial isopods; a discussion of the evolutionary significance of Peripatus; a description of recent researches on the organic cycle in the soil; and some hints on the collection and preservation of zoological specimens. Wherever possible, the articles are illustrated and add to the interest of a useful journal which deserves the support of those who are interested in New Zealand biology. Inquiries about the journal should be addressed to W. H. Dawbin, of the Zoology Department, Victoria University College, Wellington, New Zealand.

Glasgow Art Gallery and Museums: Report for 1949–50

The annual report of the Glasgow Art Gallery and Museums for 1949–50 is the first to be issued under the separate administration of the Museums and the Art Gallery. Apart from the reporting of what may be regarded as routine work, it is interesting to note that experiments in the lighting of the galleries is continuing, that an exhibition of sculpture in the open air attracted more than twenty-eight thousand visitors, and that seventeen pictures have been treated in the Art Gallery. According to modern practice, the Museums Department now deals with the scientific and historical collections. Much work has been carried out on the conservation of material. The initiation of a scheme for 'study stores' is proving successful. Begun as one for birds and one for geology, it is hoped to extend the idea to include mammals, osteology, insects and botany.

History of Zinc

The Zinc Development Association, of Lincoln House, Turl Street, Oxford, has published "Zinc and Spelter: Notes on the Early History of Zinc", and copies will be sent to *bona fide* inquirers on request. The publication, written by J. M. Dawkins, contains interesting historical material and is illustrated by quotations from books often difficult to obtain. It gives an interesting and accurate account of the subject and is a real contribution to the literature of the history of chemistry and metallurgy.

Canadian Awards for Postgraduate Research

The National Research Council of Canada has recently awarded 215 scholarships, totalling 192,100 dollars, for postgraduate research in 1951–52; this is a record, both in the number of awards and total of money, the corresponding figures for last year being 192 scholarships and 140,225 dollars, respectively. The awards are grouped into five classes: overseas postdoctorate fellowships, seven at 2,500 dollars; fellowships, thirty at 1,200 dollars; special scholarships, fourteen at 900 dollars; studentships, ninety-two at 900 dollars; and bursaries, seventy-two at 600 dollars. The fourteen special scholarships are for study abroad at the following universities: three each at London and Oxford, two at California, and one each at the California Institute of Technology, Cambridge, Harvard, Iowa, Ohio and Paris. The seven overseas postdoctorate fellowships are for work at British universities as follows: two each at Cambridge and London, and one each at Birmingham, Leeds and Oxford.

Beit Memorial Fellowships for Medical Research

Beit Memorial junior fellowships for medical research, of value £600 a year, have been awarded to the following for work in particular fields at the

places shown: Dr. Pamela M. Holton (chemical transmission at nerve endings), Physiological Laboratory, Cambridge; H. F. Jarvie (psychological manifestations of organic nervous disease), Department of Neurology, Radcliffe Infirmary, Oxford; Eleanor W. McCloy (lysogenic bacillus strain), London School of Hygiene and Tropical Medicine; A. F. Phillips (mechanism of the therapeutic action of X- and gamma-rays), Department of Radiotherapeutics, Cambridge, E. V. Rowsell (biochemical changes associated with physiological activity in nerve tissue), University of London Institute of Psychiatry, Maudsley Hospital, London; W. G. Spector (mechanism of protein synthesis in premature and full-term neonates in infancy and childhood), Graham Research Department, University College Hospital Medical School, London.

British Standards Institution: Anniversary Celebrations and Exhibition

The British Standards Institution (at 24/28 Victoria Street, Westminster, London, S.W.1), which this year is celebrating the fiftieth anniversary of its foundation, is holding an exhibition, entitled "British Standards—The Measure of Industrial Progress", at the Science Museum, South Kensington, London, S.W.7, during June 18–28 (10 a.m.–7 p.m.; closed on June 24). The exhibition will be open to the public except on June 22, when it will be reserved for members and guests of the Institution attending the conversazione on that day, which is being held as part of the jubilee celebrations. The exhibition will cover about fifty industries in Great Britain and will illustrate the development of standardization and the benefits that have accrued from it. Part of the display will be shown at the Engineering Centre, Sauchiehall Street, Glasgow, during July 9–14.

Announcements

H.R.H. The Princess Royal has been elected Chancellor of the University of Leeds, in succession to the late Duke of Devonshire.

A. N. Colefax, senior lecturer in the Department of Zoology, University of Sydney, has been elected president for the year 1951–52 of the Linnean Society of New South Wales.

Dr. D. K. C. MacDonald, at present an I.C.I. Research Fellow at the Clarendon Laboratory, Oxford, has accepted a senior research appointment in the Physics Division of the National Research Council, Ottawa, Canada, for the purpose of establishing a laboratory for low-temperature physics, primarily directed towards the field of the solid state. He intends to sail for Canada in September.

The twelfth session of the International Commission on Illumination is to be held in Stockholm during June 26–July 7. The Commission meets every three years, the last meeting being in Paris in 1948, when more than four hundred delegates from sixteen countries attended. Some seventy delegates from Great Britain are attending the Stockholm meeting. Particulars can be obtained from the Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

The Essex Field Club is offering a Lister–Scourfield–Main Memorial Prize for 1952 as a memorial to three Essex naturalists. The Prize is worth ten guineas and will be given for papers on field-study having special reference to the county of Essex. Further details can be obtained from the honorary secretary of the Club at the Essex Museum of Natural History, Romford Road, Stratford, London, E.15.

The International Research Centre for Chemica Microbiology, Rome, the head of which is Prof. E. B. Chain, is to be opened on June 25. A symposium on "Bacterial Growth and its Inhibition" will be held at the Centre during June 25–30; this is being sponsored by the Istituto Superiore di Sanità, the Council for the Co-ordination of International Congresses of Medical Sciences, and the World Health Organization.

As part of the semicentennial celebration of the United States National Bureau of Standards, a symposium on "The Solution of Simultaneous Equations and the Determination of Eigenvalues" will be held at the Institute for Numerical Analysis (a section of the Bureau's Applied Mathematics Laboratory), Los Angeles, during August 23–25. The symposium will include surveys of methods, both theoretical and practical, and related computational procedures adapted to hand machines, punched-card equipment, and automatic digital computing machines for the solution of the two types of problems. The chairman will be Prof. J. Barkley Rosser, of Cornell University. Further details can be obtained from the National Bureau of Standards, Washington 25, D.C.

The Second International Congress of Physiology and Pathology of Animal Reproduction and of Artificial Insemination will be held in Copenhagen during July 7–10, 1952, with the following programme: physiology of reproduction; pathology of reproduction; artificial insemination of domestic animals. Dr. John Hammond (Cambridge) has been nominated president, Prof. Nils Lagerlöf (Stockholm) vice-president, and Prof. Ed. Sørensen (Copenhagen) secretary-general. Further details can be obtained from Prof. Ed. Sørensen, Royal Veterinary and Agricultural College, Bülowsvej 13, Copenhagen 5.

The ninth International Management Congress will be held in Brussels during July 5–11, under the auspices of the International Committee of Scientific Management. The main part of the programme will consist of twelve introductory reports on chosen subjects relating to management in industry and affairs. Each report will be a contribution by a particular country; but the international aspect of the theme will not be neglected. After the Congress about twenty representatives will make a special thirty-day study tour of the Belgian Congo. Further details of the Congress can be obtained from the British Institute of Management, 8 Hill Street, London, W.1.

The sixth annual electronics exhibition, organized by the North-Western Branch of the Institution of Electronics, will be held at the College of Technology, Manchester, on July 24 (2.30 p.m.–9 p.m.) and July 25–26 (10 a.m.–9 p.m.). An extensive programme is planned, including, in addition to the products of commercial exhibitors, a non-commercial section composed of exhibits from universities and from scientific associations. Admission will be by tickets obtainable from the honorary secretary of the Branch, W. Birtwistle, 17 Blackwater Street, Rochdale, Lancs. Catalogues will be available early in July.

REDUCTION OF GLUTATHIONE BY CO-ENZYME II

Glutathione Reductase in Pea Seeds

THE appearance of reduced glutathione in the initial stages of seed germination is known from the work of Firket and Comhaire[1] and of Vivario and LeClaux[2], who found that, although it is absent from dry pea seeds, sulphydryl compounds appear shortly after hydration of the seeds. Hopkins and Morgan[3] confirmed their results and showed that powdered ungerminated dry pea seeds when suspended in buffered solutions reduce added oxidized glutathione. Though the reaction was presumably catalytic, the hydrogen donor and the co-factors were not identified.

We have demonstrated the enzymatic reduction of oxidized glutathione by extracts of dry pea seeds at the expense of *d*-*iso*citric acid or *dl*-malic acid in the presence of co-enzyme II and manganous or magnesium ions.

The enzymatic preparation was derived from dry ungerminated pea seeds. The seeds were ground to a powder, extracted with six times their weight of cold acetone, and air dried. The acetone powder, which is stable, was extracted with five times its weight of 0·025 *M* phosphate buffer *p*H 6·2, and centrifuged. The supernatant was used directly or after dialysis against the same buffer for 44–48 hr. at 1° C.

The enzyme activity was evaluated as the rate of production of reduced glutathione from added oxidized glutathione. The reduced glutathione was determined as the increase of iodine (0·002 *N*) titre over the control, when titrated in acid deproteinized solutions. The experiments were carried out under nitrogen, using 20 ml. of crude or dialysed enzyme, plus added oxidized glutathione, and other specified adjuvants, in a total volume of 40 ml.

The crude extract will reduce added oxidized glutathione, as is shown in Fig. 1*a*, and the activity decreases with increasing time of dialysis. The activity is partially restored by the addition of a boiled, filtered extract of pea seeds, as is shown in Fig. 1*b*. Full activity is restored to the dialysed enzyme by the addition of *dl*-malate, co-enzyme II, and manganous or magnesium ions, as is shown in Fig. 2, but co-enzyme I is inactive. *Iso*citric acid is at least as satisfactory a substrate as malate. The activity is increased upon the addition of manganous or magnesium ions; with manganous ions, the rate is maximal at 4×10^{-4} *M*. Though the amount of reduced glutathione formed is dependent upon the quantity of oxidized glutathione added, the rate is independent of the latter in the range 0·325–0·975 m*M* in 40 ml. Since both the malic and *iso*citric dehydrogenases are specific for co-enzyme II, presumably any dehydrogenase coupled with it will bring about the reduction of oxidized glutathione.

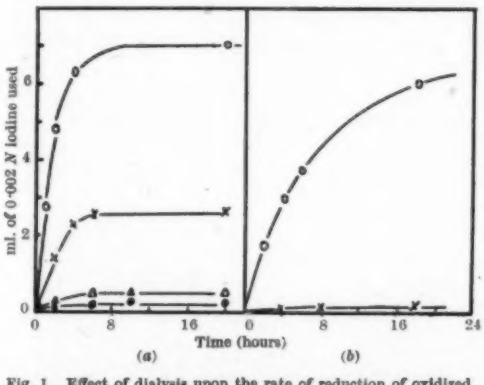


Fig. 1. Effect of dialysis upon the rate of reduction of oxidized glutathione by a pea extract and restoration of the activity. (0·65 m*M* of oxidized glutathione, 25° C.)
(*a*): O—O, undialysed enzyme; ×—×, dialysed 17 hr.; Δ—Δ, dialysed 41 hr.; ●—●, dialysed 72 hr.
(*b*): ×—×, dialysed 72 hr.; O—O, dialysed plus boiled, filtered extract

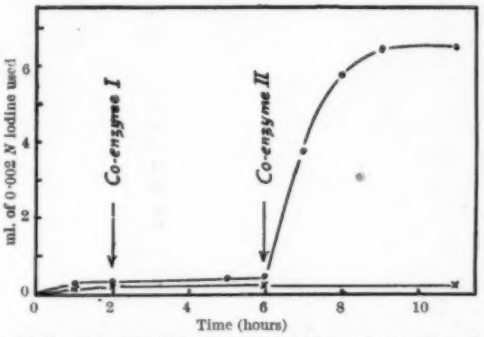


Fig. 2. Influence of co-enzymes I and II on the reduction of oxidized glutathione by malate. (0·65 m*M* oxidized glutathione, 25° C.)
×—×, dialysed enzyme; O—O, dialysed enzyme plus *dl*-malate (0·008 *M*) plus manganous ions ($1·6 \times 10^{-3}$ *M*); co-enzyme I and II (10 μgm./ml.) added at arrows

That a catalysed reaction between reduced co-enzyme II and oxidized glutathione occurs was demonstrated on the spectrophotometer. The co-enzyme II was reduced with the theoretical amount of *iso*citric acid, and the dehydrogenase from heart muscle[4] made to *p*H 8·5 and boiled for 2 min. The oxidation of the reduced co-enzyme II was followed by the decrease of light absorption at 340 mμ on the Hilger spectrophotometer, after the addition of oxidized glutathione and enzyme, as shown in Fig. 3. That the reaction is stoichiometric is shown by the fact that 0·115 μ*M* of oxidized glutathione resulted in the formation of 0·11 μ*M* of co-enzyme II from 0·17 μ*M* of reduced co-enzyme II initially present. Reversal of the reaction, that is, reduction of co-enzyme II by reduced glutathione, could not be demonstrated in the presence of a six-fold excess of the latter; apparently the equilibrium point lies well over in favour of the formation of reduced glutathione. Though Bukin[5] claims that reduced co-enzyme I will reduce oxidized glutathione, all our efforts to demonstrate such a reaction, with or without an enzyme preparation, have failed.

Since pea seedlings contain ascorbic acid oxidase, and ascorbic acid reductase bringing about the reduction of dehydroascorbic acid, glutathione reductase completes the catalytic series essential for the transfer of electrons from metabolites through co-enzyme II, reduced glutathione and ascorbic acid to molecular oxygen. We have, in fact, found these series of reactions are catalysed by the pea extract. Whether ascorbic acid oxidase is, in fact, a terminal oxidase in plant respiration still remains to be estab-

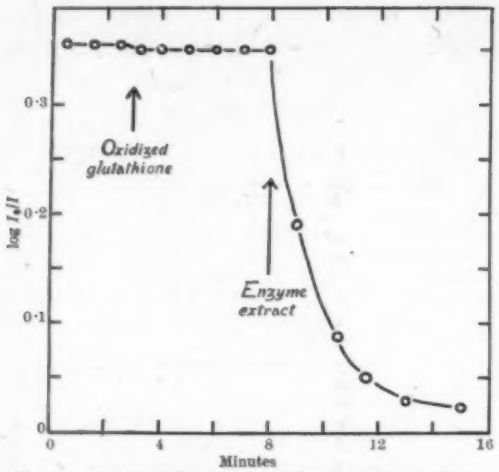


Fig. 3. Oxidation of reduced co-enzyme II by oxidized glutathione. System contained initially 1·5 ml. 0·1 *M* phosphate buffer, and 130 μgm. reduced co-enzyme II in a total volume of 3 ml. After 3 min., 250 μgm. oxidized glutathione, and after a further 5 min. the enzyme extract were added

lished. It is possible that glutathione and ascorbic acid play a regulatory part in the cell, and the two reductases serve with reduced co-enzyme II to maintain them in the reduced state.

L. W. Mapson
Low Temperature Research Station for Research in Biochemistry and Biophysics, University of Cambridge and Department of Scientific and Industrial Research.
David R. Goddard*
Botany School, Cambridge.
Jan. 9.

* Fellow of the John Simon Guggenheim Foundation, February–September, 1950.

[1] Firket, M. J., and Comhaire, M., *Bull. Acad. Roy. Méd. Belg.* (5), **9**, 93 (1929).
[2] Vivario, R., and LeClaux, J., *Arch. Intern. Physiol.*, **32**, 1 (1930).
[3] Hopkins, F. G., and Morgan, E. J., *Biochem. J.*, **30**, 1446 (1936).
[4] Graffin, A. L., and Ochoa, S., *Biochem. et Biophys. Acta*, **4**, 205 (1950).
[5] Bukin, V. N., *Biokhimiya*, **8**, 60 (1943).

Enzymatic Reduction of Glutathione by Triphosphopyridine Nucleotide (Co-enzyme II)

In 1935, Meldrum and Tarr[1] demonstrated that oxidized glutathione was reduced to the sulphydryl form in the presence of hexose-6-phosphate, crude triphosphopyridine nucleotide, and enzyme preparations from rat blood or yeast. Their results suggested the possible existence of an enzyme, distinct from *Zwischenferment*, catalysing the reaction:

$$TPNH + GSSG + H^+ \rightarrow TPN^+ + 2GSH.$$

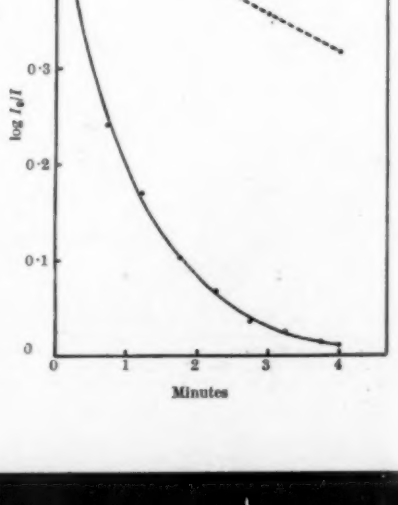
We have obtained direct evidence for the presence of such an enzyme in wheat germ. (T. W. Rall and A. L. Lehninger in this laboratory have been working independently on an enzyme in animal tissues which catalyses the reduction of oxidized glutathione by reduced co-enzyme II and appears, therefore, to be identical in action to the wheat-germ enzyme. We wish to express our appreciation to them for making their unpublished results freely available to us, and for providing us with a preparation of oxidized glutathione.)

The protein employed in these studies was prepared by extracting commercial, unheated wheat germ for 30 min. with 4 volumes of water. The precipitate obtained between the concentrations of 150 and 250 gm. ammonium sulphate per litre of original extract was collected by centrifugation, dissolved, and dialysed against 0·025 *M* phosphate of *p*H 7·4 until free from sulphate. This solution was again fractionated with ammonium sulphate, and the protein precipitated between concentrations of 220 and 250 gm. per litre was dissolved, dialysed as before, and centrifuged at 18,000 *g* to remove insoluble material. The yield was 140 mgm. soluble protein per 100 gm. original wheat germ.

This preparation was relatively free from enzymes destroying the pyridine nucleotides, but contained an enzyme system catalysing the aerobic oxidation of reduced co-enzyme II[2]. The reduction of oxidized glutathione was first detected during a study of the effects of possible inhibitors and accelerators on this reduced co-enzyme II-oxidase. Since the oxidation of reduced co-enzyme II by oxidized glutathione was so much more rapid than the oxidation by molecular oxygen, the two reactions could readily be differentiated, even under aerobic conditions.

The oxidation of reduced co-enzyme II was followed by measurement of the disappearance of light absorption at 340 mu in Corex cuvettes in a Beckman spectrophotometer. The light absorption was measured against a blank containing all additions except the reduced co-enzyme II. The reduced co-enzyme II (52 per cent pure) used in these experiments was generally prepared from co-enzyme II by a slight modification of Ohlmeyer's method[3] for reduced diphosphopyridine nucleotide. Identical results were obtained in a few experiments with reduced co-enzyme II prepared by reduction of co-enzyme II with glucose-6-phosphate and the Warburg–Christian *Zwischenferment*[4].

The accompanying graph shows the results of a typical experiment, in which the reaction mixture consisted of 0·23 μ moles of reduced co-enzyme II and 2·2 mgm. of the wheat germ protein preparation, in 3·0 ml. of 0·033 *M* tris(hydroxymethyl) amino



methane buffer of *p*H 7·4. The lower curve shows the change in log I_0/I observed in the presence of 0·8 μ moles oxidized glutathione. The upper dotted line shows the change observed in the absence of added oxidized glutathione. If the protein was held in a boiling-water bath for one minute, it caused no change in light absorption, either in the presence or absence of oxidized glutathione.

Since, under aerobic conditions, oxygen competes with oxidized glutathione as a hydrogen acceptor, anaerobic conditions were used to measure the reduced glutathione formed. The amounts of oxidized glutathione, reduced co-enzyme II and enzyme used were the same as in the aerobic experiment, but the reaction was carried out in evacuated Thunberg tubes. After eight minutes, the tubes were opened and the reaction stopped immediately by addition of metaphosphoric acid. The protein precipitate was centrifuged off and the reduced glutathione was determined directly on an aliquot of the supernatant by the colorimetric method of Fujita and Numata[5]. Another aliquot was carefully neutralized to *p*H 7·4 with solid sodium bicarbonate and analysed for co-enzyme II by measuring the increase in light absorption at 340 mu upon addition of glucose-6-phosphate and *Zwischenferment*. From 0·23 μ moles of reduced co-enzyme II and 0·8 μ moles of oxidized glutathione added initially, 0·20 μ moles co-enzyme II and 0·40 μ moles reduced glutathione were formed, giving good agreement with the equation. No reduction of oxidized glutathione occurred in the absence of added reduced co-enzyme II. Experiments designed to detect a possible reduction of co-enzyme II by reduced glutathione gave uniformly negative results.

Cystine ($1·7 \times 10^{-4}$ *M*) could not be substituted for oxidized glutathione, and reduced co-enzyme I could not be substituted for reduced co-enzyme II. This latter result appears particularly significant, since Bukin[6] has reported that reduced co-enzyme I and oxidized glutathione react non-enzymically. We could detect no such interaction at the concentration-levels we employed.

The wheat-germ enzyme, which may be termed a glutathione reductase, provides a bridging reaction for the transfer of hydrogen from all substrates of co-enzyme II-dehydrogenases to oxidized glutathione. The oxidation of reduced glutathione by dehydro-ascorbic acid, and the aerobic oxidation of ascorbic acid, complete a chain of hydrogen transport to molecular oxygen which may operate whenever the appropriate enzymes are present in sufficient concentration. The glutathione reductase and dehydro-ascorbic acid reductase can act together with the co-enzyme II dehydrogenases to maintain glutathione and ascorbic acid in their reduced forms, and this may, of course, constitute their primary function[6-9].

ERIC E. CONN
BIRGIT VENNESLAND

Department of Biochemistry,
University of Chicago,
Chicago, Illinois.
Jan. 9.

[1] Meldrum, N. V., and Tarr, H. L. A., *Biochem. J.*, **29**, 108 (1935).
[2] Conn, E. E., and Vennesland, B., *Federation Proc.*, **9**, 162 (1950).
[3] Ohlmeyer, P., *Biochem. Z.*, **297**, 66 (1938).
[4] Kornberg, A., *J. Biol. Chem.*, **182**, 805 (1950).
[5] Fujita, A., and Numata, I., *Biochem. Z.*, **300**, 246 (1939).
[6] Bukin, V. N., *Biokhimiya*, **8**, 60 (1943).
[7] Hopkins, F. G., and Morgan, E. J., *Biochem. J.*, **30**, 1446 (1936).
[8] Crook, E. M., and Hopkins, F. G., *Biochem. J.*, **32**, 1356 (1938).
[9] Crook, E. M., and Morgan, E. J., *Biochem. J.*, **38**, 10 (1944).

SOME REACTIONS IN THE IRON–CARBON SYSTEM: APPLICATION TO THE TEMPERING OF MARTENSITE

By L. J. E. HOFER and E. M. COHN
Synthetic Liquid Fuels Branch, Bureau of Mines,
Bruceton, Pennsylvania

PREVIOUS publications from these laboratories have characterized two modifications of iron carbide, Fe_2C[1], and have described some of the reactions in the iron–carbon system[1-4]. Although these carbides are being studied because of their occurrence in iron Fischer–Tropsch catalysts, it now appears that they can also be obtained from tempered martensite. Thus, Jack[5] identified a hexagonal close-packed (ε-phase) iron carbide, to which he assigned the formula Fe_2C, in martensite tempered near 200° C. Roberts[6] found cementite and poorly-defined X-ray diffraction patterns, probably due to Hägg iron carbide (χ-phase of Jack), in martensite tempered at 260° and at 371°. Both Isaïchev[7], and Crafts and Lamont[8], found 'higher' iron carbides after tempering martensite near 300°, but they did not identify the products. Antia *et al.*[9] showed three distinct stages which occur during the tempering of martensite: (1) martensite → ferrite + transition precipitate (about 80°–175° C.); (2) austenite → ferrite + transition precipitate (about 230°–290° C.); (3) formation of cementite (about 260°–400° C.). No identification of the transition precipitate was made, although a Curie point higher than that of cementite was observed. (References to older work on the stages of martensite tempering can be found in Antia's, Jack's, and Roberts's publications.)

Carburized iron catalysts containing 50 per cent or more of carbide were used in this study, obviating the necessity for further concentration. The crystallites were sufficiently large to yield well-defined X-ray powder photographs, and identification by thermomagnetic analysis was facilitated.

The carbon content appears to have only a small effect on the temperature-ranges of the reactions and on their rates[10], so that a comparison between these specimens and the intermediate products found in tempered, martensitic carbon-steel seems valid. The effect of the promoters that were incorporated in the catalyst used for this study as well as of the particle size appears to be small, as shown by the close coincidence of the temperature intervals of the tempering stages found by Antia *et al.* and in this study.

In order to study the second and third stages of the tempering of martensite by analogy, a catalyst was used consisting of a precipitated iron–copper–potassium oxide (100 : 10 : 0·32) catalyst preparation which was made at the same time as one previously described[1], and was treated identically with it (virtually complete reduction at 220°, subsequent carburization at 188° with carbon monoxide), except that carburization was stopped after 24¾ hours, when the carbon/iron ratio was 0·06966 as measured by weight gain. (This value is slightly less than the theoretical value for cementite, Fe_3C, namely, 0·07163.) X-ray analysis showed the preparation to consist of ferrite (α-Fe) and ε-iron carbide with the same lattice parameters as reported previously for the ε-phase iron carbide, Fe_2C[1], agreeing well with those reported

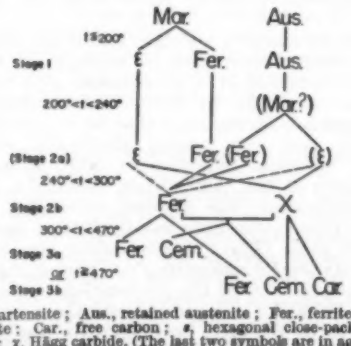
by Jack for his ε-iron carbide, Fe_3C[5]. Thermomagnetic analysis of the preparation showed a point of inflexion at about 340°; but this probably was not a Curie point because reactions occurred at a measurable rate already at about 240° C. Since considerable amounts of ferrite were present, the chemical formula could not have been Fe_3C, though it is not impossible that the carbide contained less than the stoichiometric amount of carbon necessary for Fe_3C.

Portions of this preparation were sealed in evacuated glass tubes and decomposed isothermally in a magnetic balance[1,11-13]. The course of the reactions could be followed by noting the change of total magnetic moment with time. The ferromagnetic ε-iron carbide (Curie point above 300°) decomposed into χ-iron carbide (Curie point 245°–250°), the magnetic moment of which was much smaller than that of the ε-iron carbide at the lowest temperatures used and disappeared completely at higher temperatures. The χ-iron carbide, in turn, reacted with ferrite according to the reaction[3]:

$$\chi\text{-}Fe_2C + \alpha\text{-}Fe \rightarrow Fe_3C \qquad (1)$$

at temperatures at which the magnetic moments of both carbides are zero. This reaction was magnetically detectable, however, because of the change in total magnetic moment due to loss of ferrite, the Curie point of which (about 770°) is well above the temperatures employed. The products of these reactions were analysed magnetically[4] and by X-ray powder diffraction photograms[1]. Detailed results of this study will be published. Assuming a comparison between these reactions and those occurring during the tempering of martensite to be valid, the scheme of the reactions is incorporated in the accompanying diagram, which summarizes the chemical changes occurring during the tempering of carbon-martensite.

A study of the development of the first stage was, of course, outside the scope of the present work and has already been made[6]. The temperature ranges necessary to reach stages 2*b* and 3*a* agree well with those given by Antia *et al.*[9]. However, it does not seem to have been clearly recognized as yet that the 'transition carbide' in martensite must itself undergo a transition, since the ε-phase is found in stage 1 and the χ-phase in stage 2 [6]. The ε-phase decomposes into the χ-phase above about 300° in a fully carburized (no ferrite present) catalyst[1] in a measurable time interval, but it does so already at about 240° in the partially carburized catalyst used for the present study. The carburization of a reduced iron catalyst with carbon monoxide at 240° also yielded only the



Mar., martensite; Aus., retained austenite; Fer., ferrite; Cem., cementite; Car., free carbon; ε, hexagonal close-packed iron carbide; χ, Hägg carbide. (The last two symbols are in agreement with Jack's nomenclature)

χ-phase[1]. Stage 2*b* must thus represent not only the decomposition of retained austenite, but also the transformation of the ε-phase—which is already present—into the χ-phase. If this ε-phase does not have the composition Fe_2C but corresponds to Fe_3C (as suggested by Jack) then the excess iron must segregate as ferrite, because the χ-phase (Fe_2C) has only a narrow range of composition[14]. This possibility is indicated by the dashed lines.

It is not known whether any tempering reactions occur in the interval from about 200° to 240°. If some of the retained austenite does react in that interval, it must decompose (possibly by way of martensite) into ferrite and ε-carbide, or perhaps a mixture of ε- and χ-carbide; this possibility is indicated as a possible stage 2*a* in the diagram.

The products in the third stage have been shown to be ferrite and cementite[6]. It would ordinarily be difficult to prove the presence of free carbon in such a mixture. However, the reaction

$$3\ \chi\text{-}Fe_2C \rightarrow 2Fe_3C + C \qquad (2)$$

is known to occur above about 500° in a fully carburized catalyst[4] during a measurable interval of time, and it was found in this study to proceed already at about 480°. Hence, another stage is indicated in the diagram, stage 3*b*, in which reactions (1) and (2) occur simultaneously, with the result that some free carbon is formed and a corresponding amount of ferrite does not react with the χ-iron carbide, so that the total amount of ferrite present is greater after complete tempering *above* about 470° than after complete tempering *below* that temperature. It must be borne in mind that the indicated temperatures are only approximate values which may change with changes in composition of the steel, and that the indicated reactions go to completion only after a certain length of time which depends on the temperature of tempering. If the tempering is interrupted before that time, the product consists of a mixture of the phases of two stages. A mixture of the phases of all three stages is not to be expected in plain carbon-steels, because cementite forms much too slowly in the range of relative stability of the ε-iron carbide, and the latter decomposes too rapidly in the temperature-range in which cementite forms readily.

This investigation forms part of a thesis to be submitted by E. M. Cohn to the University of Pittsburgh in partial fulfilment of the requirements for the M.S. degree. [Dec. 14.

[1] Hofer, L. J. E., Cohn, E. M., and Peebles, W. C., *J. Amer. Chem. Soc.*, **71**, 189 (1949).
[2] Pichler, H., and Merkel, M., U.S. Dept. Interior, Bureau Mines Tech. Paper 718 (1949).
[3] Hofer, L. J. E., and Cohn, E. M., *J. Chem. Phys.*, **18**, 766 (1950).
[4] Cohn, E. M., and Hofer, L. J. E., *J. Amer. Chem. Soc.*, **73**, 4662 (1950).
[5] Jack, K. H., *Acta Cryst.*, **3**, 392 (1950); see also Heidenreich *et al.*, *Nature*, **157**, 518 (1946).
[6] Roberts, E. C., *J. Metals*, **188**, 1210 (1950).
[7] Isaichev, I. V., *Zhur. Tekh. Fiz.*, **17**, 839 (1947); from *Chem. Abs.*, **44**, 3861i.
[8] Crafts, W., and Lamont, J. L., *J. Metals*, **188**, 551 (1950).
[9] Antia, D. P., Fletcher, S. G., and Cohen, M., *Trans. Amer. Soc. Metals*, **32**, 290 (1944).
[10] Fletcher, S. G., and Cohen, M., *Trans. Amer. Soc. Metals*, **32**, 333 (1944).
[11] Storch, H. H., Anderson, R. B., Hofer, L. J. E., Hawk, C. O., Anderson, H. C., and Golumbic, N., U.S. Dept. Interior, Bureau Mines Tech. Paper 709 (1948).
[12] Hofer, L. J. E., Cohn, E. M., and Peebles, W. C., *J. Phys. Coll. Chem.*, **53**, 661 (1949).
[13] Hofer, L. J. E., Cohn, E. M., and Peebles, W. C., *J. Phys. Coll. Chem.*, **54**, 1161 (1950).
[14] Jack, K. H., *Proc. Roy. Soc.*, A, **195**, 56 (1948); *Nature*, **158**, 60 (1946).

NUTRITIONAL FACTORS IN REPRODUCTIVE FAILURE

By Dr. B. P. WIESNER and Prof. JOHN YUDKIN
Department of Physiology, King's College of Household and Social Science, University of London

APPRECIABLE evidence has now accumulated from animal experiments that normal reproductive function does not occur in the absence of some as yet unidentified nutritional factor (or factors) contained, for example, in liver[1]. It seems possible to suppose that some instances of sub-fertility in women may be due to deficiency of similar nutritional factors.

As a preliminary to clinical trials, it was necessary to develop a technique for determining the activity of preparations which were to be used, for it seemed doubtful whether some of the usual pharmaceutical preparations of liver necessarily contain the factors required for reproductive efficiency. It is also hoped by such experiments to investigate further the source, nature and mode of action of these factors.

Experimental. The relevant experiments were carried out on a strain of albino rats (*KC* 1) derived from the Wistar strain. The control and experimental groups were always set up by even distribution of litter mates. The stock diet consisted of cubes supplemented daily with milk and green vegetables (Table 1). This diet has been fed to this strain of rats for the past eleven years and has given good

Table 1. Composition of Stock Diet

	Per cent		Per cent
Whole wheat	19·2	Meat and bone meal	9·5
Wheat middlings	12·0	White fish meal	5·0
Whole oats	19·0	Dried brewer's yeast	1·3
Whole barley	7·5	Cod liver oil	0·5
Yellow maize	9·5	Sodium chloride	0·5
Dried separated milk	14·0	Molasses	2·0

These components were compressed into cubes, which were fed *ad libitum*. In addition, each animal received about 5 ml. fresh milk and 5 gm. fresh greens twice weekly.

Table 2. Composition of Purified Diet and Supplement

Diet	Per cent	Vitamin solution	
Sucrose	60	Vitamin B_{12}	25 μgm.
Casein (Glaxo vitamin-free)	20	Riboflavin	150 μgm.
Arachis oil	15	Choline HCl	5 mgm.
Salts	5	Inositol	1·1 mgm.
		Nicotinic acid	500 μgm.
		Ca pantothenate	500 μgm.
		Pyridoxine	40 μgm.
		Biotin	1 μgm.

The diet was fed as a powder *ad libitum*.

The vitamin solution was made up to contain the above amounts in 0·5 ml., which was given daily. In addition, 100 mgm. cod liver oil and 1 mgm. α-tocopherol were given twice weekly on different days. In the earlier experiments, wheat-germ oil was given instead of the tocopherol, by incorporating 2 parts in place of 2 parts of arachis oil in the diet.

growth and reproduction. The composition of the experimental diets is shown in Table 2. Folley, Henry and Kon[1] found that a purified diet of similar composition supported reproduction with their strain of rats, although at a low level. The diets were fed from weaning (aged about twenty-three days). The control females and the males employed for mating were fed the stock diet.

Three preparations of liver were used for supplementation of the diets: (*a*) raw beef liver (about 1 gm. daily); (*b*) cod liver, freed from most of its oil by grinding and centrifugation (0·5 gm. daily); (*c*) dried beef liver made by mincing whole washed dried liver, drying in vacuum ovens at a temperature not exceeding 140° F. and grinding in a ball mill (0·25 gm. daily).

The rats were paired when fifteen weeks old. In order to eliminate variations which might have arisen from differences in the fertility of the males, a strict routine of randomized mating was observed.

Results. In all our experiments, reproduction on the purified diet with the vitamin supplement was severely impaired. The addition of raw beef liver, raw cod liver or dried beef liver improved reproduction, although it did not result in as good a performance as the stock diet. On the other hand, liver added to the stock diet did not further improve reproductive performance. For simplicity we have combined the results of the various experiments so as to show four groups of animals, namely: (1) purified diet with vitamin supplement but without liver; (2) purified diet supplemented with vitamins and with liver; (3) stock diet; (4) stock diet supplemented with liver.

Table 3. Effect of Diet on Interval from Pairing to Parturition
(Figures give average number of days)

Diet	Purified	Purified and liver	Stock	Stock and liver
Expt. 1	39	34	27	—
Expt. 2	77	69	28	30

All the diets supported growth and resulted in puberty at the usual age. Animals maintained on the purified diets took longer to produce litters than those on the stock diets (Table 3). The addition of liver to the purified diet reduced this difference slightly.

Animals on the purified diets also had appreciably smaller litters (average 6·3 pups) than those on the stock diet (average 9·9) (Table 4). Liver added to the purified diet increased the litter size to a mean of 8·1, but had no significant effect when added to the stock diet.

The most striking difference produced by the diets concerned the survival of pups, that is, the true fertility of the animals. Of the pups born to animals maintained on a purified diet without liver, all died within three days. When liver was added to this purified diet, at least some pups survived to weaning in nearly half the litters, and a total of about one-third of all pups born survived. Survival of litters and pups was still better on the stock diet, with or without liver.

The deficiency affected both mother and young. In a few experiments in which young were exchanged between mothers on the purified diet without liver and others on the stock diet, some of the young from the former survived, though no doubt they all would have died if left with their own mothers. Conversely, some stock young survived with foster-mothers kept on the purified diet, though these foster-mothers failed to rear their own young.

Our results confirm the view that liver contains a nutritional factor or factors necessary for reproduction and not identical with any of the better-known factors. The nature of this factor, which we shall call for convenience 'reproductive factor *R*', is being studied in further experiments on rats of strain *KC* 1 which shows *R*-deficiency so clearly. So far, we have indications that the content of liver of vitamin B_{12} may account for part but not all its *R*-activity. The fact that reproductive performance on a purified diet with liver is still inferior to that on a stock diet suggests that the stock diet not only contains this factor but also either contains others or has a better balance of nutrients.

Table 4. Effect of Diet on Reproduction

Diet	No. of animals	Litters No. born	Litters No. weaned	Litters Per cent weaned	Pups No. born	Pups No. weaned	Pups Per cent weaned	Pups per litter Born	Pups per litter Weaned
Purified	17	15	0	0	95	0	0	6·3	0
Purified and liver	23	20	9	45	163	57	36	8·1	6·3
Stock	10	10	10	100	99	79	80	9·9	7·9
Stock and liver	9	9	8	90	90	68	75	10·0	8·5

The experiments were carried out with samples from fairly large batches of dried liver; those found to be active have been reserved and are available for clinical trials.

We are indebted to Messrs. Kylon, Ltd., for making available the dried liver powder and tablets. Our thanks are also due to British Cod Liver Oils, Ltd., for supplies of cod liver, and Glaxo Laboratories, Ltd., for vitamin B_{12}. We are especially grateful to Mrs. E. Blacker for her technical assistance and to Messrs. Allen and Hanburys, British Drug Houses and Messrs. H. W. Carter and Co. for financial grants towards the expenses of this Department. [Jan. 30.

[1] For example, see Folley, S. J., Henry, K. M., and Kon, S. K., *Brit. J. Nut.*, 1, 39 (1947).

A VARIABLE-RATIO SAMPLE-DIVIDER FOR GRANULAR MATERIALS AND POWDERS

By Dr. E. A. C. CHAMBERLAIN, Dr. J. B. CALDWELL and Dr. P. L. WATERS

National Coal Board, Scottish Division, Edinburgh

ONE of the major problems of coal analysis is the reduction of the sample taken in the field to a representative sample for laboratory work. From a bulk sample of coal, which in the case of large coal may amount to several hundredweights, it is necessary to prepare a small bottle of powdered coal for analysis. This is usually carried out by crushing and grinding in two or three stages, and sample-dividing, after each stage, to manageable proportions. A generally accepted procedure is as follows. The bulk sample is crushed to pass 3/16 in. mesh and then reduced to give a sub-sample of not more than 20 lb. This is then ground in one or two stages, sub-dividing at each stage to give a final ¼ lb. laboratory sample of coal through 72-mesh.

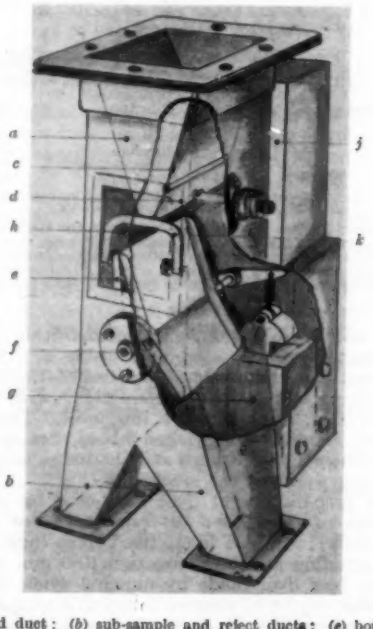
With the very large numbers of coal samples now being handled, existing methods of sample-dividing gave rise to several difficulties, either because they were slow and laborious or because they could not cope with direct discharge from a modern, swing-hammer pulverizer without a considerable dust nuisance.

It was decided that a sample divider should possess the following features: (i) it should sample-divide continuously, be automatic and require the minimum of manual operation; (ii) to meet our requirements of accuracy, it should be able to take a large number of small increments distributed evenly throughout the sample; (iii) it should be capable of rapid sample adjustment so that the ratio of sub-sample to reject may be varied at will, if possible while in operation; (iv) it should be capable of taking a large flow of coal of various crushed sizes, from ½ in. to powdered material; it should take a feed up to 50 lb./min. or 1½ tons per hour; (v) the apparatus designed for these purposes should be as compact as possible, dust-tight and easily cleaned, to prevent contamination from previous samples.

We have devised a sample divider which was designed to meet these requirements. Granular or powdered coal falls by gravity through a duct and is deflected to one side and then to the other by an oscillating chute. The timing of the movement of this member determines the volumetric ratio of the sub-sample separated out. The weight and number of increments can also be controlled by adjusting the rate at which coal is fed through the duct.

The apparatus consists of a duct (*a*), rectangular in cross-section, which forks at its lower end into two smaller ducts (*b*). Inside the upper part of the duct a small hopper (*c*) is mounted; a hinged flap (*d*) is fitted to the outlet of the hopper so that the feed of material may be adjusted. Just below the hopper, a chute in the shape of a metal vane (*e*) pivoted about a horizontal axis (*f*) deflects the falling coal. The chute is activated by two mains-operated solenoids (*g*), mounted behind the casing of the duct. The movement of the chute is restricted on either side by means of a stirrup (*k*) which is fitted on to the hopper outlet. A tapping motion is thus imparted to the hopper, ensuring that the material is fed through regularly.

The solenoids are electrically connected to a time-control box, which houses the mechanism for automatically controlling the timing movement of the



(*a*) Feed duct; (*b*) sub-sample and reject ducts; (*c*) hopper; (*d*) hinged flap; (*e*) deflecting vane or chute; (*f*) axle and pivot; (*g*) solenoids; (*h*) 'Perspex' window; (*j*) lamp housing; (*k*) stirrup

oscillating chute. This consists of a simple electrical timing circuit the function of which depends upon the time of charge and discharge of a high-capacity condenser through two variable resistances.

The over-all dimensions of the apparatus are approximately as follows: length 13½ in.; width 7 in.; depth 7 in. The ranges of operation of the apparatus are as follows:

(i) Rate of feed: crushed, air-dried coal, 5–50 lb./min.; ground coal down to 2 lb./min. The feed of coal will also depend upon the rate at which it is discharged from the crushing or grinding plant.

(ii) Proportions of sub-sample to gross sample: timing movement, 0·1–5 sec. (The upper time limit can be extended to any desired value.)

(iii) Number of increments per min., 300 (at 1 : 1); approximately 10 (at 1 : 50).

(iv) The size of each increment will depend upon the rate of feed and rate of taking increments; for example, for timing movement of 0·1 sec.:

Rate of feed (lb./min.)	Wt. of increment (oz.)
2	0·053
5	0·13
10	0·26
20	0·52
40	1·04

Although the apparatus was originally designed for sample reduction of coal, it is also suitable for use with other types of freely flowing, granular or powdered materials.

MOVEMENTS OF SALMON ALONG THE COASTS OF NORTHERN IRELAND

By ARTHUR E. J. WENT

Department of Agriculture, Fisheries Branch, Dublin

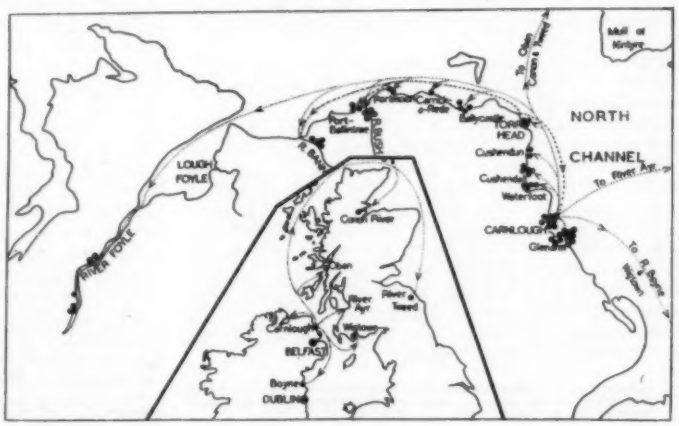
At a meeting of the International Council for the Exploration of the Sea in Edinburgh in October 1949, the Salmon and Trout Committee of that body, having considered the results of the tagging of salmon off the west and south coasts of Ireland, passed a resolution suggesting that the fishery authorities of Northern Ireland, England and Wales, Scotland and the Republic of Ireland should collaborate in working tagging stations along the coast of County Antrim (Northern Ireland). A small sub-committee, consisting of the late George Steven (Northern Ireland), F. T. K. Pentelow (England and Wales), K. A. Pyefinch (Scotland) and myself (Republic of Ireland), was set up to settle the necessary details. As the result of two meetings of this sub-committee, it was found possible to carry out a limited amount of tagging in 1950, Messrs. Allan, Alabaster, Sutherns and Swain from London and Messrs. Gibson and O'Driscoll and I from Dublin doing the tagging with the assistance of Messrs. Edwards, Murray and Whale of the Fisheries Branch of the Ministry of Commerce, Belfast.

Details of Recapture of Salmon tagged at Carnlough and Torr Head, Co. Antrim, in 1950

Place of recapture	Tagged at Carnlough			Tagged at Torr Head		
	No. recaptured	Distance travelled		No. recaptured	Distance travelled	
		miles	km.		miles	km.
River Boyne	1	118	190	—	—	—
Glenarm	11	2–3	3–5	—	—	—
Carnlough	7	—	—	1	15	24
Waterfoot	4	8	13	—	—	—
Cushendall	5	8	13	—	—	—
Cushendun	2	10	16	—	—	—
Torr Head	3	15	24	—	—	—
Ballycastle	4	23	37	—	—	—
Carrick-a-rede	1	27	42	—	—	—
Portmoon	2	34	55	—	—	—
Portballintrae	2	39	63	1	24	39
River Bush	4	40–42	64–68	—	—	—
River Bann and Tributaries	3	50–85	81–137	1	40	64
River Foyle	5	71–87	114–140	—	—	—
River Ayr	1	78	125	—	—	—
Wigtown Bay	1	92	148	—	—	—
Loch Feochan (near Oban)	1	110	177	—	—	—
Conon River	1	450	724	—	—	—
River Tweed	1	615	990	—	—	—
Total	59	—	—	3	—	—

Operations were carried out during nine week-ends from mid-May onwards, and salmon taken by two bag-nets at Carnlough and Torr Head, County Antrim, were tagged with Lea's hydrostatic tag (designed and manufactured by Mr. Einar Lea, Fiskerikonsulant, Frederiksgate, 3, Oslo) and released. In all, 150 fish (138 at Carnlough and 12 at Torr Head) were tagged. Up to December 20, 1950, 62 recaptures (41·3 per cent of the fish tagged) have been reported, 59 from fish tagged at Carnlough and 3 from fish tagged at Torr Head. Recaptures were made on the coast of Ireland and in Irish rivers from the Boyne on the south to the Foyle on the north-west. Three recaptures were made on the west coast of Scotland, one on the east coast of Scotland and one in the River Tweed (see accompanying table and sketch map). Seven fish were recaptured in the same net from which they had been released (namely, at Carnlough) and they were at liberty from 2 to 43 days.

The apparent rates of travel, which, of course, must be regarded as minimum speeds, were lower than those recorded in the Scottish and Norwegian experiments[1]. One fish travelled 71 miles (114 km.) at the rate of 23·6 miles (38·0 km.) per day, and the



longest two migrations, 615 miles or 990 km. (to the River Tweed) and 450 miles or 724 km. (to the Conon River), were accomplished in 47 and 31 days, respectively, or at the rate of 13·1 miles (21·1 km.) and 14·5 miles (23·3 km.) per day, respectively.

These experiments have clearly indicated a substantial movement of salmon north-westwards along the coasts of County Antrim, a result which was somewhat unexpected.

[1] See Menzies, W. J. M., "The Stock of Salmon" (London: Edward Arnold and Co., 1949).

TAXODIACEOUS CONIFERS*

IT is seven years since the discovery was announced of living *Metasequoia* in China, and already the elegant saplings are familiar. It is but ten years since Miki first distinguished the fossil genus from the Japanese Tertiary.

We now learn that *Metasequoia* was the chief Taxodiaceous conifer, and no doubt a forest dominant, over a great part of the northern hemisphere, especially North America and not merely in eastern Asia. It is surprising that it awaited discovery so long, for its fossil shoots were figured more than eighty years ago, and hundreds have been studied in more recent times. Its most obvious distinguishing character, its opposite leaves, are easily recognized in a fossil; but for some reason this character was either missed or ruled out as unimportant. The first to recognize it properly was Endo in Japan in 1928 (who based a species on this character), and Miki later found additional differences in shoot, in cone and in structure, and rightly distinguished it generically.

There are three fossil Taxodiaceous genera with rather similar foliage: true *Sequoias* resembling *S. sempervirens*, *Metasequoias* resembling *M. glyptostroboides* and true *Taxodiums* resembling *T. distichum*. Chaney shows that the three genera are easily distinguishable by several macroscopic characters. Before the recognition of *Metasequoia* the confusion was grievous since the numerous fossil *Metasequoia* specimens were forced into the two remaining genera, spoiling both. The confusion does not exist in Europe because, apparently, *Metasequoia* never grew here (unless a few pollen grains represent it). However, Chaney leaves us nothing to be complacent about; he makes it clear that the old descriptions of our Tertiary *Sequoias* are too bad for anyone to use nowadays, and he does, in fact, neglect them in his comparisons.

According to Chaney, *Metasequoia* has two American species, one less abundant in the Cretaceous, the other, *M. occidentalis*, being abundant in the older Tertiaries but disappearing in the Miocene. He cites fifty references to the Tertiary species, half under the names of five species of *Taxodium*, the other half under six species of *Sequoia*. The most abundant true Tertiary *Sequoia* has only twenty-five records under five specific names, but *Taxodium dubium* does better with forty records under seven species of *Taxodium*, five of *Sequoia* and a few others. A paper which reduces names like this is a joy. Even these remaining names are of doubtful status since some of the fossils may be identical with the living species or with the European fossils.

* A Revision of Fossil Sequoia and Taxodium in Western North America based on the Recent Discovery of *Metasequoia*. By Ralph W. Chaney. *Trans. Amer. Phil. Soc.*, N.S., **40**, Pt. 3 (1951).

Many respected palæobotanists are exposed in Chaney's gallery of those who made the mistake of confusing *Metasequoia* specimens with the other two genera. He singles himself out for obloquy; but this seems unfair—palæobotanists are no worse than other people at missing what ought to be obvious.

Chaney spares no trouble in his work; it is therefore the more interesting that he makes no use of microscopic characters. Most Tertiary palæobotanists shun the microscope, and I gather from other sources that they secretly believe that the Mesozoic palæobotanists have gone mad in pursuit of the very minute. It may well be so, for I at least, while admitting that Chaney's macroscopic characters for the discrimination between these species are convincing, would have been happier had he included their epidermal cells.

This paper deals with a noble subject, the history of the world's greatest trees, and it rises to the grand manner. The treatment is both interesting and charming, and I would recommend anybody who has to revise a confused group to see how Chaney has done his work.

TOM M. HARRIS

BRITISH IRON AND STEEL RESEARCH ASSOCIATION, 1946–50

ESTABLISHED in 1945, the British Iron and Steel Research Association got off to a more-or-less flying start, as a result of its connexions with the research committees of the Iron and Steel Institute, with which the late Dr. W. H. Hatfield was so intimately concerned. An impressive account has now been published by the Association of the results of the first five years of its activities*.

The Association is divided into six sections, dealing respectively with the manufacture of iron, the production of steel, mechanical working, steel castings, plant engineering and metallurgy.

Starting off at the very beginning of the industry's work, an operational study has been made of the transport of the raw materials to, and within, the works. The output of the furnaces has received similar attention, and it has been shown that the time to melt the charge in an open-hearth furnace is the shorter when the furnace is charged steadily than when a considerable weight is put in at one time. The preparation of the materials for the blast furnace is now recognized as one of the most important factors in its efficient performance, and work has been carried out on the crushing and screening of the ores, etc. Increasing supplies of fine-grained concentrates present a problem, as conventional sinter plants can only deal with them at the expense of a reduction in output. Work, therefore, is in progress on other techniques of agglomerization, particularly 'pelletizing', which consists in passing fine ore of suitable size, distribution and moisture content through a rotating drum, in which balls or pellets are formed and grow by a snowball effect; the pellets are then fired, to give adequate strength for use in the blast furnace. The experience already gained has justified the erection of a pilot plant.

In connexion with the manufacture of iron, the knowledge of the actual and relative velocities of the gas is important, for example, in assessing the advantages of the development in the United States

* Five Years of Co-operative Research, 1946–1950. Pp. 24. (London: British Iron and Steel Research Association, 1951.) Free.

of high top pressure, the effect of which is to make the gas travel more slowly, thus giving more time for the reactions between the reducing gases and the burden. Radioactive gas has been used for measuring the velocity of the gaseous flow through the furnace, the radon being projected into one tuyère by a small explosive charge. As a result of these experiments it has been found that the gas takes about seven times as long to pass through the furnace as had previously been thought. The effect of injecting lime through the tuyères of the blast furnace on the control of the slag has also been examined. Normally, when lime is added at the top, the time-lag between the addition and its effect on the slag is something of the nature of six to eight hours. With tuyère injection the delay is reduced to one to two hours, and as much as three tons of lime have been introduced in two and a half hours through half the tuyères, without detriment to the hearth or any significant change in the lime content of the flue dust.

A simplified and more efficient open-hearth design, termed the 'single uptake' furnace, has been developed. The idea of a single air-uptake terminating immediately below the gas port, although not new, seems hitherto not to have received serious study. Small-scale trials have led to most promising results, and there are now eighteen such furnaces in operation in at least eleven steel-works, and more are being installed. The design leads to increased production, better control of the melting operations, and a smaller consumption of fuel and refractory materials.

As a result of the increasing use of instrumentation in open-hearth furnaces, there are already in Great Britain at least six firms which are using automatic control in open-hearth melting shops to a considerable degree, and the performance has been so satisfactory that other similar installations are being planned.

The value of oxygen enrichment in steel-making has been the subject of considerable work, particularly in the refining of stainless steel in arc furnaces, a practice which can be economic even at the present cost of liquid oxygen. This makes it possible to raise the bath to a considerably higher temperature, with a resulting reduction in the loss of chromium; and charges consisting of all stainless-steel scrap are now being regularly refined. Oxygen is also being used in the arc furnace for refining plain carbon steels, and in the production of 4 per cent silicon transformer steels, with economies in time, current and electrodes. The oxygen content of the blast of the basic Bessemer converter may be increased to 24 per cent, the time of the blow being shortened, the quantity of scrap used increased, and the nitrogen content of the steel significantly reduced.

The importance of economies in the consumption of ingot moulds will be realized from the estimate that the steel industry, even after allowing for the value of the scrap, spends £4,500,000 a year on such moulds. It has been shown that the setting of the moulds too closely together in the casting pit has an excessively detrimental effect, the life of a mould being increased by 50 per cent simply by setting two moulds on each bogey in place of three.

In steel-making, as in the production of iron, practical studies need the support of fundamental work, and reports have been published on the thermodynamic background against which existing processes may be checked or new ones developed. Theoretical and experimental studies have been made of the relationship between carbon and sulphur in iron, the mechanism of the transfer of sulphur from furnace gases to metal, and of slag compounds in the refining of steel. Heat transfer by radiation from the flame is being examined in an open-hearth furnace made available by the Royal Dutch Steel Works, for joint trials by scientific workers from France, Holland, Sweden and Great Britain, while the size of the carbon particles responsible for the luminosity of flames and the ignition and combustion times of heavy fuels are being examined in the Association's own laboratories.

With regard to the hot fracture of castings due to cooling stresses, which has been found to occur normally round 1,400° C., it has been shown that although most normal alloying elements, when added in small quantities, increase this susceptibility to tearing, larger additions of chromium, molybdenum, titanium and vanadium reduce it. Silicosis in foundries has been studied, in collaboration with the Ministry of Labour's factory inspectorate, and pathological studies have been carried out on the effects of various materials present in foundry dust. The possibility of continuous casting or the fabrication of semi-finished steel directly from the liquid metal has attracted the steel industry for many years, and a small-scale apparatus casting bars up to 3 in. in diameter has been built and operated successfully. A detailed study of solidification-rates has been completed, and it appears probable that in the first instance the process will be rendered practical for the production of alloy steel.

Work on the rolling of steel has resulted in the development of roll force-meters for measuring loads up to 600 tons under the difficult conditions existing in the works. This instrument has made possible considerable developments in automatic control, particularly of the thickness of the strip. Considerable interest has been shown in Great Britain and the United States in methods of 'die-less' drawing, that is, the stretching of the wire between drums revolving at different speeds. Although the Association's experiments have, as yet, only reached an early stage, encouraging results have been obtained, both with steel and copper wire.

In connexion with the work on surface coatings, a method of regenerating fresh sulphuric acid from the spent liquor of the pickling bath has been developed, and a pilot-scale plant is now being built. Economic appraisal of the process on a large scale suggests that it should result in substantial savings and in conservation of sulphur.

Research on the heat-treatment of steel has resulted in the publication of "The Atlas of Iso-Thermal Transformation", in which are given the *S*-curves of many steels. The very large number of observations required meant that this publication could only have been produced by the co-operative effort of many laboratories; and it is clear that here, as in all the Association's work, such collaboration of the individual works and the assistance of their scientific personnel has made the achievements of the past five years possible.

Work on steels for high-temperature service in steam plants, on methods of analysis, corrosion, the brittle fracture of mild-steel ship plates, fundamental researches on brittleness, X-ray methods for following directly the change of structure of a steel during transformation, and a high-temperature microscope with a magnification up to 500 and working up to 1,000° C., are some of the other aspects of the Association's activities which are here summarized.

F. C. Thompson

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Theory of Magnetic Storms and Auroras

Under the above title, Dr. D. F. Martyn has published an article in *Nature* of January 20, 1951, which is of much interest.

Dr. Martyn's treatment is founded on Chapman–Ferraro's theory of magnetic storms. It is not my intention to review here the objections to this theory—objections which I believe to be fatal—nor is it worth while to discuss the curious superstructure which Dr. Martyn tries to erect on this weak ground. It is much more interesting to recall Dr. Martyn's statement that "the strength of the Chapman–Ferraro theory lies in the extreme care with which each necessarily occurring process has been analysed". This brings up the question in what parts of geophysics it is possible to analyse a phenomenon so carefully that really "each necessarily occurring process" could be found. In some rather simple cases it probably *is* possible. In more complicated cases, however, it is a very dangerous method which should be used with great care and only when no other way is possible. The theoretical geophysicist should learn from the physicists that a topic can be developed only by intimate contact with experiment.

These remarks may appear to be trivial, but Dr. Martyn's article has demonstrated the necessity of stressing them for the field of electric currents in gases. This is a subject on which very much laboratory work has been done during this century. Many theories have been formulated with much care; but even if they have started from correct assumptions about the properties of atoms and electrons, it has again and again been shown that many of them were not tenable. This is due to the fact that the field is very complicated, because so many different factors may enter. However carefully a theoretical worker has selected what factors should be of importance for a certain phenomenon, he will very often find from experiment that Nature has another opinion about what factors are essential. Nobody who has studied the present theory of spark breakdown or the streamer mechanism of a flash of lightning will believe that any theoretician, however skilful, would have been able to give an *ab ovo* theory of it starting from general principles without knowing anything of the experimental results.

The theoretical geophysicist has no greater chance than the theoretical physicist of making a correct guess about the important factors. Moreover, he has much less chance of being quickly corrected when he has started on a wrong road. The only remedy for this seems to be a much better contact with laboratory experiments. Many of the formulæ which have been worked out for application to geophysical problems might, and should, be checked in the laboratory. For example, even Chapman–Cowling's formula for the electric conductivity in an ionized gas should be used with some hesitation, not because any fault has been made in the admirable calculations leading to it, but because there is no experimental check. It would not be at all astonishing if in some cases it were wrong by several orders of magnitude, because factors which have not been included in the calculations turn out to be more important than those which have been included. In fact, measurements of the diffusion of a plasma across a magnetic field have shown that in some cases this is some hundred times more rapid than expected, presumably due to plasma oscillations[1].

It is very annoying to all theoreticians in this field that we know so little about plasma oscillations except that they are very important. So far no real theory of them exists. In this respect they may be considered as analogous to turbulent phenomena, which upon the whole can be treated only in a semi-empirical way. Applying empirical criteria for the occurrence of plasma oscillations to the problems in Chapman–Ferraro's theory, there are indications that such oscillations may be of decisive importance. If this is so, the claim that "each necessarily occurring process has been analysed" seems exaggerated.

My conclusion is that in many fields of geophysics we should not attempt to go directly from our writing-desk to cosmical phenomena. It is much better to call at the laboratory on our way out. If our theoretically derived results are found in the laboratory to be in error, there is little chance that they will be right when applied to the geophysical phenomena.

This stresses the importance of scale-model experiments, which indeed was fully realized by Birkeland, the founder of the electromagnetic part of geophysics. In order to find what electrical phenomena occurred during a magnetic storm, he put up a 'terrella' imitating the earth with its magnetic field in as good a vacuum as was attainable at that time and started an electric discharge. He observed luminous rings around the poles, similar to the aurora. Unfortunately, the theory of discharges in gases was quite undeveloped at that time so it was impossible for him to interpret the phenomenon. Dr. Malmfors's repetition of this experiment under much better controlled conditions has demonstrated how important experiments of this type are for the understanding of geophysical phenomena.

H. Alfvén

Royal Institute of Technology,
Stockholm.

[1] Cf. Bohm, D., Burhop, E. H. S., Massey, H. S. W., and Williams, R. M., Chapter 9 of "The Characteristics of Electrical Discharges in Magnetic Fields", p. 173 (National Nuclear Energy Series, 1:5: 1949).

No one will disagree with Prof. Alfvén when he stresses the desirability of attempting scale-model experiments of geophysical phenomena in the laboratory. Unfortunately, experience shows that unambiguous experiments of this type are hard to make: a recent study of such an experiment devised by Chapman[1] to test theories of magnetic storms reveals some of the difficulties. It would seem that in the field of low-pressure physics, Nature still provides the laboratory best suited for illustrating fundamental principles in action. Certainly, to date, all scale-model attempts to illustrate theories of magnetic storms have yielded ambiguous results: in Alfvén's own recent words[2], "we ought to be careful in applying a result from a scale-model experiment to Nature".

Prof. Alfvén considers that Chapman and Ferraro's work cannot be thorough since it apparently takes no account of plasma oscillations. It is unfortunate that these authors' long series of papers on magnetic storm theory have not been more widely read, possibly because of their mathematical difficulty and the modesty of their claims. In point of fact, Chap-

man and Ferraro *did* develop[3] the theory of plasma oscillations, on the walls of conducting slabs and cylinders, at a time when these were being independently discovered in the laboratory by Tonks and Langmuir, and by J. J. Thomson. Chapman and Ferraro deduced that neutral beams of ions and electrons would pass freely across a magnetic field under conditions where plasma oscillations occurred on the boundaries; if they had awaited laboratory demonstration of this, the progress of magnetic storm theory would have been retarded by two decades.

Prof. Alfvén still believes that Birkeland's model of the current system in magnetic storms can explain the observed facts, in spite of the careful refutation of this model by Vestine and Chapman[4]. Recently, at my suggestion, Mr. C. B. Kirkpatrick[5] has re-examined the Birkeland model, substituting current sheets for line currents, in an attempt to make it fit the facts. He fully confirms Chapman and Vestine's conclusion that even with substantial modification the Birkeland current scheme cannot be valid.

Prof. Alfvén makes no specific criticism of my extension of Chapman and Ferraro's work; doubtless his stimulating comments on this will be available in due course. All workers in the field must welcome careful critical discussion of this difficult subject.

D. F. Martyn
Council for Scientific and Industrial Research,
Radio Research Board,
c/o Commonwealth Observatory,
Mount Stromlo, Canberra.

[1] Chapman, S., *J. Atmos. and Terr. Phys.*, **1**, 189 (1951).
[2] Alfvén, H., "Cosmical Electrodynamics", 203 (Oxford Univ. Press, 1950).
[3] Chapman, S., and Ferraro, V. C. A., *Terr. Mag.*, **36**, 77 (1931).
[4] Vestine, E. H., and Chapman, S., *Terr. Mag.*, **43**, 351 (1938).
[5] Kirkpatrick, C. B. (to be published shortly).

Geomagnetic Effects of Solar Flares

From a study of the geomagnetic effects produced at widely separated stations on three occasions of intense solar flares, McNish[1] concluded that "the change in the magnetic field caused by the chromospheric eruption consisted of an augmentation of the diurnal-variation departure, obtaining at that time in each element". This result, which has had important repercussions on the theory of the solar and lunar daily magnetic variations, was supported by Newton's[2] paper concerning the geomagnetic flare effects occurring at Abinger (England) during 1936–46.

A recent investigation of the geomagnetic solar flare effects at Lerwick (Shetland Islands) and Eskdalemuir (Dumfriesshire, Scotland) during 1936–49 has brought to light the interesting fact that while McNish's conclusion is fully substantiated by the horizontal (H) and declination (D) components of the magnetic flare effects at both stations, the vertical (V) component generally opposes in sense both the V component of the corresponding flare effect at Abinger and that of the normal magnetic daily variation at the respective Scottish stations. This result is interpreted as indicating that there are substantial differences between the space distribution of the ionospheric currents producing the geomagnetic effects of flares and those producing the normal daily magnetic variations. The 'normal' departures at Lerwick, Eskdalemuir and Abinger during most of the daylight hours are such as might be produced by an approximately east–west ionospheric current flow with maximum concentration north of Lerwick, while the magnetic effects produced at the three stations by solar flares are generally such as to show that the ionospheric current flow producing these effects has a zone of maximum current concentration not far south of Eskdalemuir.

The results of the investigation will be published in full elsewhere.

I am indebted to the Director, Meteorological Office, for permission to publish this note.

D. H. McIntosh
Meteorological Office,
Edinburgh.
Feb. 15.

[1] McNish, A. G., *Terr. Mag.*, **42**, 109 (1937).
[2] Newton, H. W., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 200 (1948).

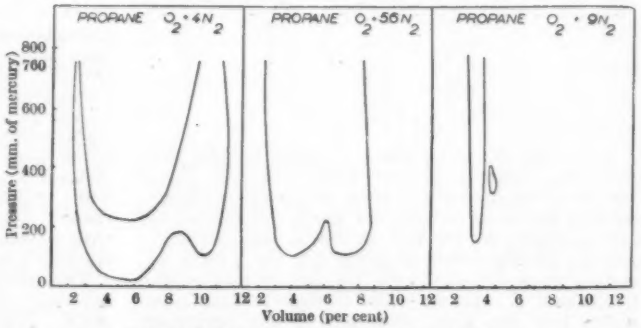
Inflammability Ranges of Propane - Air Mixtures under Reduced Pressure

Investigations of the inflammability ranges of propane – air mixtures have led investigators to assume the possible existence of a complex system of overlapping ranges occurring at high concentration in propane and presumably appearing when a powerful enough source of ignition is used.

Ignition in our case was obtained by a spark produced by an air condenser charged at 22,000 volts passing through two small platinum electrodes at the base of a closed tube 4 cm. in diameter and 80 cm. high. The device used allowed us to employ either a single spark, corresponding to a single charge and discharge of the condenser, or a train of such sparks (duration of whole less than one second). The single spark gave the classical inflammability-range[1] whereas the train of sparks led to a considerably widened one.

The particular shape of the inflammability limit diagram led us to the hypothesis of an overlapping system of two different ranges, due to two different mechanisms of combustion.

The effect of increasing the nitrogen content in these mixtures was further investigated in the hope of separating the two ranges. The accompanying diagrams show the different concentration and



Inflammability ranges of propane–air–nitrogen mixtures

pressure limits, together with the change in character of the ranges obtained.

We wish to express our thanks to Dr. D. T. A. Townend for interesting suggestions made during our visit to the British Coal Utilization Research Association, Leatherhead, last September.

This investigation is being continued in this Laboratory and will be described fully later.

R. Delbourgo
P. Laffitte

Laboratoire de Chimie Générale,
Faculté des Sciences,
Paris.
Feb. 6.

[1] Smith, E. C. W., *Proc. Roy. Soc.*, A, **174**, 110 (1940).

g-Factors of Binary Ferrites at Low Temperature

A physical theory of the magnetic properties of ferrites has recently been given by Néel[1]. Experimental investigations by which this theory may be tested include those of E. W. Gorter[2] on the saturation magnetization of a number of simple and mixed ferrites at low temperature, and of H. G. Beljers and D. Polder[3] on the g-factors of nickel–zinc ferrites of various compositions at room temperature.

It is desirable to determine the g-factors of these materials at the same low temperatures at which the saturation magnetization has been measured. In the present work, g-factors have been obtained for various ferrites by a resonance method over a temperature range of 0° C. to −195° C., using spherical specimens 2 mm. in diameter, and a wave-length of 3·2 cm. The results for the two extreme temperatures are shown in the accompanying table.

g-Factors of Binary Ferrites

Composition: $x\ M_aFe_2O_4 + (1-x)\ M_bFe_2O_4$.

(i) M_a = Zn; M_b = Ni.

x	Ni		Cu		Mg	
	0°	−195°	0°	−195°	0°	−195°
0·0	2·26	2·39	2·09	2·32	2·04	2·24
0·2	2·40	2·69	2·10	2·33	2·06	2·37
0·4	2·40	2·83	2·21	2·47	2·07	2·44
0·6	2·40	2·69	2·11	2·44	2·05	2·53
0·8	1·98	2·16	1·95	2·07	1·93	2·11
1·0	1·93	2·06	1·93	2·06	1·93	2·06

(ii) M_a = Mg; M_b = Ni.

x	Ni		Cu	
	0°	−195°	0°	−195°
0·0	2·26	2·39	2·09	2·32
0·2	2·17	2·32	2·09	2·37
0·4	2·17	2·17	2·11	2·35
0·6	2·11	2·11	2·11	2·24
0·8	2·09	2·16	2·11	2·27
1·0	2·04	2·24	2·04	2·24

For group (i), the g-factor increases at first with increasing content of zinc ferrite, and it passes through a maximum in a composition-range approximately the same as that for which Gorter's curves give a maximum for the saturation magnetization. For the Ni–Mg ferrite in group (ii), the g-value decreases monotonically with content of magnesium-ferrite at 0° C.; but at −195° C. there is a minimum, which has also been observed[4] in the saturation magnetization. For the copper–magnesium ferrite, the g-value is practically constant at 0° C. The maximum at −195° C. has also been found[4] in the saturation magnetization.

A theoretical discussion of these results in the light of Néel's theory, and details of the apparatus, procedure and of the methods of preparation of the specimens, will be published in *Sci. Rep. RITU*.

Tosihiko Okamura
Yosiharu Torizuka

Research Institute for Scientific Measurement,
Sendai.
Jan. 19.

[1] Néel, L., *Ann. Phys.*, **3**, 137 (1948).
[2] Gorter, E. W., *Nature*, **165**, 798 (1950).
[3] Beljers, H. G., and Polder, D., *Nature*, **165**, 800 (1950).
[4] Okamura, T., and Simotaka, J., *Sci. Rep. RITU*. (in the press).

Triphenylchloroethylene, Tritylmethyl Chloride and Related Halides

Tritylmethyl chloride, $Ph_3C.CH_2.Cl$, has interesting structural features, especially from the point of view of investigations of reaction mechanism[1]. We wish to record briefly the preparation, properties and reactions of this compound, and to refer to some related halides. The substance previously listed in the literature[2] as tritylmethyl chloride is triphenylchloroethylene, $Ph_2C{=}C(Cl)Ph$.

Tritylmethyl chloride (m.p. 101·5°) was obtained in good yield from triphenylmethyl sodium and methylene chloride in ethereal solution. *Tritylmethyl bromide* (m.p. 93°) was prepared similarly, but in poor yield. An attempt to obtain the iodide (see below) by the same method gave triphenylmethane and triphenylethylene. From $Cl(CH_2)_2Cl$ and $Cl(CH_2)_3Br$, *β-tritylethyl* and *γ-tritylpropyl chloride* (m.p. 113° and 130°, respectively) have been similarly obtained. Their reactions are being examined, together with those of tritylmethyl bromide and iodide.

The following observations refer to tritylmethyl chloride. The ultra-violet absorption spectrum was found to be similar to that of 1,1,1-triphenylethane. With the Grignard reagent, water gave 1,1,1-triphenylethane, bromine gave tritylmethyl bromide, and iodine gave a rather unstable iodide (m.p. 101°, with decomp.) regarded provisionally as '*tritylmethyl iodide*'. The reaction with sodium in liquid ammonia, followed by treatment with ammonium chloride, yielded 1,1,1-triphenylethane. (All the new compounds, the names of which are italicized above, gave correct analytical data.)

At temperatures in the neighbourhood of its melting point, a slow decomposition of the chloride takes place, giving hydrogen chloride and triphenylethylene. This change is powerfully catalysed by certain metallic compounds, ferric and stannic chlorides being particularly active. Interaction with benzene in the presence of aluminium chloride gave *sym.*-tetraphenylethane. The reaction with sodium appears to be tardy, and the thermal decomposition of the chloride is a complication; in petroleum solution at 120°, triphenylethylene was isolated from the products. A preliminary examination of the reactions with Grignard reagents in the presence of cobaltous chloride yielded indefinite results.

Tritylmethyl chloride exhibits very marked steric hindrance in bimolecular nucleophilic replacements (S_N2). The reactions in hydroxylic solvents are not of this type: they are fairly facile, their rates are

unaffected by added alkali, and they yield triphenylethylene.

The foregoing properties are consistent with the conclusion that rearrangements of the Wagner type accompany the formation of the cations of certain carbon structures, but not their anions[1]. The evidence regarding the fate of the neutral tritylmethyl radical is as yet inconclusive.

In agreement with the description of earlier workers[2], we observed that the reaction of 1,1,1-triphenylethane with phosphorus pentachloride at 190°–200° gives a substance of melting point 118°. However, contrary to previous conclusions[2], this is not tritylmethyl chloride. We submit evidence that it is triphenylchloroethylene, the course of its formation probably being as follows:

$$Ph_3C.CH_3\ (1) \rightarrow Ph_3C.CH_2.Cl\ (2)\ [\rightarrow Ph_2C(Cl).CH_2Ph?] \rightarrow Ph_2C{=}CHPh\ (3) \rightarrow Ph_2C{=}C(Cl)Ph.$$

By the action of phosphorus pentachloride at 195°, the same compound was obtained from (1), (2) and (3), and its ultra-violet absorption spectrum was found to be similar to that of triphenylethylene. Finally, the substance was identified by direct comparison with a sample of triphenylchloroethylene obtained by the elimination of hydrogen chloride from 1,1,2-triphenyl-1,2-dichloroethane[3]. We have confirmed the observation of Wooster and Mitchell concerning the formation of 1,1,2-triphenylethane by the interaction of the compound with sodium in liquid ammonia. However, our information on the structure of the halide renders inapplicable the significance which was attached to the observation by the previous investigators.

Unaware of our work in this field, Dr. Grovenstein (private communication) obtained tritylmethyl chloride from triphenylmethyl sodium and methylene chloride, and observed the similarity of its ultra-violet absorption spectrum with that of 1,1,1-triphenylethane. He has also concluded independently that the compound of Cone and Robinson is triphenylchloroethylene.

J. C. Charlton
I. Dostrovsky
E. D. Hughes

University College of North Wales, Bangor.
University College, London, W.C.1.
Feb. 2.

[1] Dostrovsky, Hughes and Ingold, *J. Chem. Soc.*, 173 (1946).
[2] Cone and Robinson, *Ber.*, **40**, 2160 (1907). cf. Wooster and Mitchell, *J. Amer. Chem. Soc.*, **52**, 1042 (1930).
[3] van de Kamp and Sletzinger, *J. Amer. Chem. Soc.*, **63**, 1879 (1941).

Steric Retardation and Steric Acceleration

Steric effects may be either thermodynamic or kinetic, that is, they may influence either reaction equilibria or reaction rates: this note is concerned with kinetic steric effects. Such effects depend on mechanism, and even the sign of a kinetic steric effect can be altered by a change of mechanism. 'Steric hindrance', obviously an inadequate title under which to summarize thermodynamic steric effects, thus becomes inadequate even to cover all kinetic steric effects.

By definition, steric effects depend on changes of non-bonding energy: when the non-bonding energy in an initial or transition state of reaction, or, more exactly, when the difference between the two energies is not negligible in relation to the energy of activation, then we say that a kinetic steric effect is under observation.

In the bimolecular mechanism of nucleophilic substitution (S_N2), for example:

$$\overset{-}{HO} + R.Br \rightarrow \left[\overset{\delta-}{HO}\ldots R\ldots \overset{\delta-}{Br}\right] \rightarrow HO{-}R + \overset{-}{Br},$$

a greater compression of groups in the transition state (indicated in brackets) than in the initial state often causes appreciable steric retardation: a semi-quantitative theory of this effect has been offered[1]. On the other hand, in unimolecular reactions (S_N1, $E1$, etc.) having, as rate-determining step, a simple heterolysis, for example:

$$R.Br \rightarrow \left[\overset{\delta+}{R}\ldots \overset{\delta-}{Br}\right] \rightarrow \overset{+}{R} + \overset{-}{Br},$$

the separation of the expelled group, without an accompanying covalent attachment of the substituting agent, may result in the release of initial non-bonding compression energy, and therefore may cause steric acceleration.

In substitutions, steric retardation is more familiar than steric acceleration, for the reason that compression energies in the transition states of bimolecular substitution are often considerable for quite simple structures, while comparable compressions in initial states are present only in certain rather complex compounds. For the *neo*pentyl halides, greatly restricted substitution-rates (for example, by 10^{-5} as compared with *n*-alkyl halides) have been associated with the bimolecular mechanism[1]. However, the unimolecular reactions of compounds of the same general order of complexity show no such marked kinetic effects, either retarding or accelerative. To illustrate, the following relative rates[2] of unimolecular solvolysis of tertiary halides in '80 per cent' aqueous ethyl alcohol at 25° are all of the same order of magnitude ($CMe_3Cl = 1$): CMe_2EtCl, 1·6; CMe_2Pr^nCl, 1·5; CMe_2Bu^nCl, 1·4; CMe_2Pr^iCl, 0·9; CMe_2Bu^tCl, 1·2; $CMeEt_2Cl$, 2·4; CEt_3Cl, 2·8; CEt_2Pr^iCl, 2·0. Brown[2d] has utilized a form of steric strain theory in discussion of results of this type, taken in conjunction with some of a more significant nature.

Large facilitating effects of alkyl substituents have been observed in corresponding unimolecular reactions of somewhat more complex halides ($CMe_3Cl = 1$): $CMePr^i_2Cl$, 14; CEt_2Bu^tCl, 48 (ref. 2*f*); CBu^t_3Cl, 600 (ref. 3). It is difficult to establish rigorously that nothing but steric acceleration is here being illustrated, that is, that the excessive rates come from the release during reaction of non-bonding energy only. The possibility of acceleration by the release of bonding energy is to be discussed in a later communication. However, the suddenness with which the kinetic effect enters as the density of ramification is increased is very characteristic of steric effects[1]. We have known for some time that the unimolecular hydrolysis rates of mono *tert.*-butylmethyl and simple primary alkyl halides are nearly the same[4]. It has now been found[2e] that the unimolecular solvolysis rates for di-*tert.*-butylmethyl chloride (in 80 per cent aqueous ethyl alcohol the Arrhenius frequency factor is $2{\cdot}6 \times 10^{19}$ sec.$^{-1}$ and the activation energy 26·5 k.cal./mole) are of quite the same order as for simpler secondary alkyl chlorides[2b]. Yet, as noted above, the solvolysis rates for tri-*tert.*-butylmethyl chloride (for example, $k_1 = 5{\cdot}4 \times 10^{-3}$ sec.$^{-1}$ in 80 per cent aqueous ethyl alcohol at 25°) are very much larger than those of simpler tertiary alkyl chlorides.

In the reactions of di- and tri-*tert.*-butylcarbinols with hydrogen halides (the solvolysis of related alkyl halides is being examined similarly) fission of the carbon framework occurs, so that, in addition to the normal and Wagner re-arranged halides, lower halides, notably *tert.*-butyl and *tert.*-amyl halides, are produced. Such fission is particularly facile with the tri-*tert.*-butyl compound. These are essentially unimolecular eliminations (*E*1), in which the ion *t*-Bu$^+$ separates from where a proton usually does[5], such separation probably attaining observed rates partly on account of steric factors[2d]. The stages between initial heterolysis and final chloride-ion uptake may be written thus:

$$Bu^t_3C^+ \rightarrow Me_2\overset{+}{C}.CMeBu^t_2 \rightarrow Me_2C{:}CMeBu^t + t\text{-}Bu^+$$

$$Bu^t_2CH^+ \rightarrow Me_2\overset{+}{C}.CHMeBu^t \rightarrow Me_2C{:}CHMe + t\text{-}Bu^+$$
$$\searrow$$
$$t\text{-}Am^+$$

F. Brown
T. D. Davies
I. Dostrovsky
O. J. Evans
E. D. Hughes

University College of North Wales, Bangor.
University College, London, W.C.1.
Feb. 2.

[1] Dostrovsky, Hughes and Ingold, *J. Chem. Soc.*, 173 (1946).
[2] (*a*) Hughes, *J. Chem. Soc.*, 255 (1935). Cooper, Hughes, Ingold and MacNulty, *ibid.*, 1183, 1283 (1937). (*b*) Hughes, Ingold, Martin and Meigh, *Nature*, **166**, 679 (1950), and unpublished results. (*c*) Shorter and Hinshelwood, *J. Chem. Soc.*, 2412 (1949). (*d*) Brown and Fletcher, *J. Amer. Chem. Soc.*, **71**, 1845 (1949).
[3] (*a*) Results of present authors. (*b*) Prof. P. D. Bartlett and co-workers reported similarly large factors at an International Colloquium in Montpellier, France (April 1950), where our results and conclusions were also communicated.
[4] Dostrovsky and Hughes, *J. Chem. Soc.*, 171 (1946).
[5] Hughes and Ingold, *J. Chem. Soc.*, 2038 *et seq.* (1948). cf. Whitmore and Stahly *J. Amer. Chem. Soc.*, **55**, 4153 (1933).

Synergistic Effect of a Third Active Glycoside of Senna

Stoll *et al.*[1,2] have isolated from senna (leaf and fruit of *Cassia acutifolia* Delile and *C. angustifolia* Vahl.) the active glycosides, sennosides *A* and *B*, which, they state, represent about 90 per cent of the total glycosidal content. No evidence is given, however, that the entire activity of the crude drug is due to these glycosides.

As part of a general investigation on this group of anthraquinone drugs, we have compared the biological activities of the pure sennosides with that of samples of the leaf and fruit, and in no instance does the activity of these glycosides account for the total activity of the crude drug. Furthermore, samples of leaf containing much less sennosides than samples of fruit had similar biological activities. We have investigated the likely theories which would explain these discrepancies and have found that there is a third glycoside (or glycosides ?) present in small amounts which is as active as the sennosides and, more important, exerts a marked synergistic effect when present in a proportion of about 15 per cent of the total glycosidal content. Proportions of about 5 per cent exerted practically no synergistic action.

In the samples of leaf referred to above, this third glycoside represented about 12–15 per cent of the total glycosides, whereas in the samples of fruit it represented only 2–4 per cent. These facts would therefore explain why a sample of leaf is as active as a sample of pod even though it contained much less sennosides, and also may go a long way to accounting for the total activity of the crude drug.

Further details will be published elsewhere.

J. W. Fairbairn
M. R. I. Saleh

Pharmacognosy Department,
School of Pharmacy,
University of London,
17 Bloomsbury Square,
London, W.C.1.
Feb. 22.

[1] Stoll, A., Kussmaul, W., and Becker, B., *Verh. Schweiz. Natf. Ges.*, 235 (1941).
[2] Stoll, A., Kussmaul, W., and Becker, B., *Helv. Chim. Acta*, **32**, 1892 (1949).

Tissue Metabolism and Peripheral Circulation

The regulation of blood flow in the peripheral tissues is still an unsolved problem in the physiology of the circulation. The cause of reactive hyperæmia following the release of a previously clamped artery has been attributed to an accumulation of specific vasodilator substances (as acetylcholine, histamine, etc.), or to metabolites with vasodilator effects (especially lactate and *p*H changes). Rein[1] regards the co-operation of both factors as the clue to a proper blood supply.

In our experiments, the carbohydrate metabolism of muscles was inhibited at various levels. The metabolic rate of the poisoned area, the response of its vessels to some vasodilator substances, adrenaline, and the development of reactive hyperæmia were investigated. Experiments were performed *in vivo* on anæsthetized dogs. The blood-flow of the area (comprising 95 per cent muscle) was measured, the blood of which was channelled through the vena profunda femoris[2]. Arterio-venous oxygen difference was measured colorimetrically[3]; lactate was determined by the method of Elgart and Harris[4].

The infusion of 1–2 per cent iodoacetic acid into the arteria profunda femoris (0·8 c.c./min. for 20 min.) caused a marked increase of blood flow and lactate production, accompanied by a smaller increase of oxygen uptake. Later, all three values decreased, and, 3–4 hr. after the infusion, lactate production was below its starting level and a gradually ensuing contracture of the vessels set in.

The Pasteur reaction due to the intra-arterial infusion of potassium cyanide (0·8 mgm./min.), which is normally accompanied by a very marked vasodilatation, is abolished after 1–2 hr. following iodoacetate infusion. At this stage of the experiment both potassium cyanide and acetylcholine cause vasoconstriction, instead of vasodilatation. Reactive hyperæmia is either completely abolished or appears only in a very reduced form. Nitroglycerine and perparine (a tetraethoxy derivative of papaverine) are without effect. The sensitivity to epinephrine is unchanged, but vasoconstriction is not followed by consecutive vasodilatation.

Iodoacetate, as an inhibitor of —SH, inhibits the synthesis of acetylcholine, which, according to Burn's investigations[5], offers a possible explanation of the inverse action of acetylcholine. It is also known[6] that during iodoacetate poisoning the adenosinetriphosphate content of the muscles decreases, and finally with the ensuing contracture adenosinetriphosphate disappears from the muscle.

Fluoroacetic acid, which inhibits Krebs's tricarboxylic acid cycle but does not interfere with acetylcholine synthesis, causes in the third hour following a 20-min. infusion an increase of lactate production with a decrease of oxygen consumption. Reactive hyperæmia, though not abolished, is delayed and in a considerably prolonged form. In some cases, acetylcholine or potassium cyanide cause vasoconstriction during their infusion, but after the end of the infusion a very considerable vasodilatation of long duration sets in in almost every experiment. The effects of perparine and nitroglycerine are unaltered.

The fact that the response of the vessel is always identical with both acetylcholine and potassium cyanide suggests that the vasodilatation due to the potassium cyanide anoxia is directly or indirectly (through an axon-reflex) mediated through the liberation of acetylcholine. The vasodilatation of long duration in the fluoroacetate-poisoned muscles due to acetylcholine or potassium cyanide may be caused in both cases by an impaired oxidation of the acetyl-radical.

It seems probable that the response of the arterioles is determined by the adenosinetriphosphate content of their smooth muscles. This is rapidly diminished by iodoacetate, as could be shown directly by Straub's method[7]. At such times both exogenous and endogenous acetylcholine liberated by potassium cyanide cause vasoconstriction. Nitroglycerine and perparine, which exert their effects directly on the arteriolar walls, are ineffective. The disappearance of adenosinetriphosphate from the muscular wall of the arterioles results in an irreversible contracture of the vessels. Fluoroacetate, on the other hand, does not inhibit the synthesis of adenosinetriphosphate to such a degree as iodoacetate. The diminished adenosinetriphosphate content, however, is not sufficient to ensure the conditions for normal acetylcholine action. Consequently higher concentrations cause vasoconstriction, which is followed (parallel with the decreasing concentration) by vasodilatation. There is, however, a sufficient amount of adenosinetriphosphate present in the muscles required for the effect of nitroglycerine and perparine.

Vasoconstrictor effects (for example, those of epinephrine) are unaltered under all conditions investigated.

These experiments are in agreement with the results obtained by Engelhardt and his collaborators, who showed that a loaded actomyosin thread relaxes in the presence of adenosinetriphosphate[8].

Further work is in progress.

B. Issekutz, jun.
I. Lichtneckert
Z. Németh-Gáspár
G. HeténYi, jun.

Physiological Department,
University of Szeged,
Hungary.
Dec. 18.

[1] Rein, H., *Pflüg. Arch. ges. Physiol.*, **248**, 111 (1944).
[2] Issekutz, jun., B., Lichtneckert, I., and Hetényi, jun., G., *Arch. Int., Pharmacodyn.*, **83**, 33 (1949).
[3] Issekutz, jun., B., Hetényi, jun., G., and Feuer, I., *J. Physiol.*, **108**, 9 (1949).
[4] Elgart, S., and Harris, J. S., *Indust. Eng. Chem.*, **12**, 758 (1940).
[5] Burn, J. H., *Physiol. Rev.*, **30**, 177 (1950).
[6] Erdös, T., Studies Inst. Med. Chem. Univ. Szeged, **3**, 51 (1943).
[7] Kramer, M., Pettkó, E., and Straub, F. B., *Kísérletes Orvostudomány*, **1**, 114 (1949).
[8] Engelhardt, V. A., Lyubimova, M. N., and Mejtina, R. A., *C.R. Acad. Biol., U.R.S.S.*, **30**, 644 (1941).

Continuous Metabolism of Hæmoglobin in the Red Cells of Peripheral Blood

During the treatment of anæmias, one frequently observes a decrease of hæmoglobin index, the increase of hæmoglobin often lagging to a greater or lesser extent behind the rise in the number of red cells. The action of folic acid or vitamin B_{12} on erythropoiesis in normal rabbits presented a particularly favourable opportunity for the analysis of this phenomenon, which, so far as we know, has not yet been the subject of a thorough study.

The subcutaneous injection of a single dose of 15 mgm. of folic acid or of 20 μgm. of vitamin B_{12} induces in rabbits, in 6–24 hr., a notable erythrocytosis[1,2]. But at the same time the hæmoglobin value, instead of increasing, remains at its initial level, with a consequent marked lowering of the colour index[2].

Table 1

Time	Red cells	Hæmoglobin (per cent)	Colour index	Reticulocytes (as percentage red cells)
Before	5,620,000	93	0·83	
5 hr. after 15 mgm. folic acid	7,000,000	93	0·66	
Before	4,140,000	80	0·97	3·0
1 day after 15 mgm. folic acid	4,900,000	74	0·75	4·5
Before	4,770,000	88	0·92	2·0
2 days after 20 μgm. vitamin B_{12}	6,060,000	88	0·75	9·0
Before	6,320,000	92·5	0·80	1·0
1 day after 20 μgm. vitamin B_{12}	8,560,000	89·5	0·53	9·0

The results shown in Tables 1 and 2 illustrate these facts. To avoid possible causes of error, we used iron estimations (Henry's method[4]) as well as the colorimetric determination of hæmoglobin, and moreover we carried out these two determinations as well as the red-cell counts on one single sample of blood. The good agreement in each case between the iron values and the hæmoglobin determined by colorimetry affords a guarantee of the accuracy of the hæmoglobin determinations.

Table 2

Time	Red cells	Hæmoglobin (per cent)	Iron (mgm./litre)	Colour index
Before	6,970,000	118	560	0·85
2 days after 20 μgm. vitamin B_{12}	7,650,000	113	550	0·75
Before	5,500,000	81	456	0·73
2 days after 20 μgm. vitamin B_{12}	6,500,000	78	450	0·60
Before	5,400,000	84	469	0·77
2 days after 20 μgm. vitamin B_{12}	6,030,000	80	450	0·67

In addition, control experiments have shown that, when carried out with the same counting-chamber and the same dilution, the possible error in the red-cell counts—the weak point of the determination of the colour index—never exceeded 5 per cent.

Lastly, the variations in colour index during erythrocytosis have, in our experiments, *always* been in the same direction, namely, a decrease.

The increase in the number of red cells (at least 25 per cent) and the stationary hæmoglobin value can be explained by the formation of new erythrocytes deprived of, or at least very deficient in, hæmoglobin. According to the law of mixtures, these particular new erythrocytes should be found in the proportion of one to every five old erythrocytes. Examination of stained smears after the action of the vitamin factors, however, reveals a homogeneous tinctorial appearance in the red cells, contrary to that which is observed with blood partly laked by a 0·4 per cent solution of sodium chloride and then brought back to isotonicity. Under the latter conditions, we observed that one erythrocyte in four had lost its charge of hæmoglobin and appeared colourless in Giemsa stained smears.

There remained the possibility of a small volume of newly formed red cells. On this hypothesis, to take into account the fall in the colour index, the new erythrocytes should have a mass at the most 20–25 per cent of that of normal red cells. If they are geometrically similar to the latter, their diameter should not exceed 60 per cent of the normal. They would, thus, in spite of the usual anisocytosis of the rabbit, be easily recognizable. In fact, systematic measurements have shown no statistically significant difference in mean cell diameter during the erythrocytosis.

These observations have led us to believe that a redistribution of hæmoglobin occurs between the old and the newly formed red cells. The mechanism of this redistribution is certainly very complex, and no doubt involves a degradation and resynthesis of the blood pigment, operating apparently in the hæmatopoietic organs. At all events one must consider that the erythrocyte, during the hundred odd days of its normal life, does not possess a fixed and immutable hæmoglobin content. On the contrary, this content can vary, particularly during the course of certain hæmatopoietic incidents.

By the use of glycine containing nitrogen-15, London and his collaborators[5] recently arrived at the same conclusions.

The hypothesis we have put forward here extends to hæmoglobin the concept of continuous metabolism, and calls to mind the turnover of lipids and proteins. But the protoporphyrin arising from the degradation of hæmoglobin is not utilized as such for the resynthesis of the blood pigment. Thus the rapidity, observed in our experimental conditions, of the turnover of hæmoglobin during the erythrocytosis requires an intense production of protoporphyrin to accommodate the speed of its resynthesis to the speed of its degradation.

This is precisely what we have found. In all our animals, the administration of folic acid or vitamin B_{12} was followed in a few hours by a considerable increase in the content in the red cells of free, non-hæmoglobin protoporphyrin.

H. Bénard
A. Gajdos
M. Gajdos-Török

Clinique Médicale de l'Hôtel-Dieu,
Paris.

[1] Bénard, H., Gajdos, A., and Gajdos-Török, M., *C.R. Soc. Biol.*, 144, 38 (1950).
[2] Bénard, H., Gajdos, A., and Gajdos-Török, M., *C.R. Soc. Biol.*, 144, 350 (1950).
[3] Henry, P., *Ann. Biol. Clin.*, **3**, 101 (1950).
[4] Bénard, H., Gajdos, A., and Gajdos-Török, M., *C.R. Soc. Biol.*, 144, 605 (1950).
[5] London, I., Shemin, D., and Rittenberg, D., *J. Biol. Chem.*, 183, 749 (1950).

Action of Vitamin B_{12}, Folic Acid and Liver Extracts on the Free Protoporphyrin Content of Red Blood Cells

The different behaviour of free erythrocyte protoporphyrin in secondary and iron-deficiency anæmias on one hand, and in Addison's anæmia on the other, is well known. In anæmias of the first types, the free protoporphyrin in the red cells increases markedly up to values of several hundreds of micrograms per 100 ml. of red cells, returning to the normal value (20–40 μgm.) on remission of the anæmia. In untreated Addison's disease, on the contrary, the concentration of the pigment is diminished, but increases considerably under appropriate treatment. We thought that this particular behaviour of the free protoporphyrin of the erythrocytes in pernicious anæmia was due to a deficiency in the synthesis of this pigment, a deficiency determined by the lack of antipernicious factors.

In search of evidence to support this hypothesis, we studied in normal rabbits the effect of a single massive dose of vitamin B_{12}, folic acid or active liver extract. In all our experiments we have noticed a rapid erythrocytosis accompanied by a marked erythrocyte hyperprotoporphyrinæmia[1,2]. These phenomena become very distinct six to twenty-four hours after injection of the antipernicious agents, as

Experiment	Time	Red cells	Hæmoglobin (per cent)	Protoporphyrin (μgm. per 100 ml. red cells)
I	Before	5,620,000	93	6·6
	5 hr. after 15 mgm. folic acid	7,020,000	95	37·5
	1 day " " " " "	6,500,000	95	57·0
	2 days " " " " "	6,000,000	93	86·0
	8 " " " " "	5,000,000		65·0
	20 " " " " "	5,400,000		3·6
II	Before	4,500,000	85	indeterminable
	6 hr. after 15 mgm. folic acid	5,350,000	85	18
	1 day " " " " "	5,280,000	85	44
	4 days " " " " "	4,900,000	82	59
	15 " " " " "	4,700,000	82	49
	20 " " " " "	4,700,000	82	20
III	Before	6,000,000	92·5	indeterminable
	1 day after 20 μgm. vitamin B_{12}	8,560,000	89·5	7
	3 days " " " " "	6,200,000	85	77
	7 " " " " "	5,500,000	85	41
	18 " " " " "	5,600,000	84	37
IV	Before	6,200,000	114	9
	3 days after 20 μgm. vitamin B_{12}	7,000,000	94	58
	6 " " " " "	5,800,000	86	75
	13 " " " " "	6,580,000	81	103
	16 " " " " "	6,300,000	81	78
V	Before	7,400,000	84	36
	3 days after 4 ml. liver extact	8,060,000	77	53
	6 " " " " "	8,000,000	77	73

indicated in the accompanying table, in which some of our observations are recorded.

Our experiments show that antipernicious anæmia agents such as vitamin B_{12}, folic acid and active liver extracts cause, in normal rabbits, a considerable increase in the free protoporphyrin content of the erythrocytes. The changes in protoporphyrin content during these experiments resemble those observed in the course of treatment of Addison's anæmia.

This augmentation of the free protoporphyrin of the erythrocytes is due, in our opinion, to the acceleration by the antipernicious anæmia factors of the synthesis of the pigment. To make this fact clear we depleted rabbits of their reserves of glycine, a material the organism uses for building porphyrin, by previous injections of high doses of benzoic acid. In animals so prepared, the injection of vitamin B_{12} or of folic acid was followed neither by an erythrocytosis, nor by an increase in the concentration of free protoporphyrin in the red cells. The subsequent administration of glycine to animals deprived of this amino-acid re-established the normal response to vitamin B_{12} or to folic acid[3].

Our investigations demonstrate a new aspect of the mechanism of action of hæmatopoietic agents effective in the treatment of pernicious anæmia. Indeed, we believe that vitamin B_{12}, folic acid and active liver extracts act, at least in part, by restoring the synthesis of protoporphyrin, a synthesis which is defective during the course of Addison's disease.

H. Bénard
A. Gajdos
M. Gajdos-Török

Clinique Médicale de l'Hôtel-Dieu,
Paris.

[1] Bénard, H., Gajdos, A., and Gajdos-Török, M., *C.R. Soc. Biol.*, **144**, 38 (1950).
[2] Bénard, H., Gajdos, A., and Gajdos-Török, M., *C.R. Soc. Biol.*, **144**, 350 (1950).
[3] Bénard, H., Gajdos, A., and Gajdos-Török, M., *C.R. Soc. Biol.* (In the press).

Effects of Choline, Acetate and Citrate on the Activity of the Choline Acetylating System of Mammalian Brain

Nachmansohn, Hestrin and Voripaieff[1] have reported that a highly active preparation, capable of synthesizing acetylcholine from acetate and choline (with certain other additions), can be obtained from extracts of acetone-dried brain (rabbit) by fractional precipitation with ammonium sulphate. The active material is contained in the 16–36 per cent fraction (16–36 gm. to 100 c.c. volume ammonium sulphate) and requires calcium ions to be fully effective. Two means of identifying acetylcholine are used: (1) assay on the frog rectus abdominis muscle and (2) chemical determination by the method of Hestrin[2]. The aforementioned authors find, however, that bioassay may give values more than twice those obtained chemically, and that incubation without choline yields bio-active material (equivalent to 80–100 μgm. acetylcholine/ml. of incubate) which is not chemically identifiable as acetylcholine. The nature of the substance responsible is unknown. It is formed largely by the 25–36 per cent ammonium sulphate fraction; and acetylcholine by the 16–25 per cent fraction.

In experiments testing similar preparations and with the same additions to the incubation mixture (acetate, co-enzyme A, tetraethyl pyrophosphate, adenosinetriphosphate, cysteine and potassium, magnesium, calcium, sodium, chloride and phosphate ions) we have also found that in the presence of choline high concentrations of acetylcholine (up to 125 μgm./ml.) can be synthesized; but we find that only negligible quantities of bio-active substance (frog rectus assay) are produced when no choline has been added (Table 1). We believe that the discrepancy is most probably due to differences in co-enzyme A preparations used. However, extensive tests using co-enzyme A of different degrees of purity and obtained from three different materials (liver, yeast and brain) have not affected our results, although some are more and some less effective in accelerating acetylcholine synthesis. Representative results are shown in Table 1.

As a further check, we have also compared the values obtained for acetylcholine estimated by bioassay with those determined chemically. In general, the chemical values are higher and fall near the three-hour value for the 'true' acetylcholine shown in the curve published by Nachmansohn *et al.*[1]. The fact that the chemically determined values are higher rather than lower than those determined by bioassay is further evidence that acetylcholine accounts for most of, if not all, the bio-activity of the samples.

Because of the demonstration by Feldberg and Mann[2] that synthesis of acetylcholine by dialysed or undialysed extracts of acetone dried brain powder is greatly potentiated by the addition of citrate (in the presence of magnesium ions), whereas acetate is without effect, we have thought it important to compare the actions of citrate (plus magnesium ions) and acetate (plus calcium ions) in the system devised by Nachmansohn *et al.*[1]. Preliminary tests have now shown that citrate can be much more effective than

Table 1

Enzyme preparation	Acetylcholine synthesized in 2½–3 hr. (μgm./ml.)		Co-enzyme preparation
	Choline added	No choline added	
RP 11 : 16–36% ammon. sulph. fraction	60	< 4	Crude hog liver (method of Kaplan and Lipmann, ref. 4)
RP 13 : 16–36% " " "	44	< 2	Sample of hog liver extract obtained from Dr. Lipmann
RP 14 : 25–36%* " " "	76	< 2·5	" " "
RP 15 : 16–25%* " " "	22	0·5–5·0	Acetone-precipitated boiled liver extract "
RP 15 : 25–36%* " " "	53	1·5–5·0	" " "
RP 22 : 25–36%* " " "	68	< 2	Purified from yeast (method of Balfour and Comline, ref. 5)
RP 22 : 25–36%* " " "	58	2·5	Boiled saline extract of acetone-dried brain (rabbit)
KP 24 : 16–25%† " " "	120	9	Purified from yeast (method of Balfour and Comline, ref. 5)

* Preparations in which recovery of precipitate formed at 25 per cent ammonium sulphate was not so complete as in other cases. Separation was effected by centrifuging and after only a brief period of standing. This procedure yields only the least soluble portion of the 16–25 per cent fraction; and the remainder is brought down with the 25–36 per cent fraction.
† Recovery of 16–25 per cent fraction was complete. This fraction was effectively separated by allowing more than an hour for precipitation to occur and collecting it by filtration (Whatman No. 15 paper).

Table 2

Enzyme preparation		Acetylcholine synthesized in 3 hr. (μgm./ml. incubate)		
		Acetate + calcium ions	Citrate + magnesium ions	
		Choline added	Choline added	No choline
RP 23 : 16–25% ammon. sulph. fraction*		28	73	4
RP 23 : 25–36% " " " *		80	105	3
RP 24 : 16–25% " " " †		125	90	–
RP 24 : 25–36% " " " †		27·5	5	–

* As in Table 1. † As in Table 1.

acetate when the enzyme is derived from the least soluble material of the 16–25 per cent ammonium sulphate fraction. Acetate and citrate can have nearly equal effects, however, when the whole of this fraction is the source of the enzyme (see Table 2).

The work now in progress has extended these observations and yielded methods for both physical and functional separation of two enzyme systems, which differ from each other in that one utilizes citrate preferentially while the other can utilize only acetate.

We wish to thank Dr. Lipmann for his kindness in letting us have a sample of co-enzyme A; and we are grateful to Dr. Neuberger and Dr. Feldberg for having arranged this on our behalf.

W. E. Balfour
Catherine O. Hebb

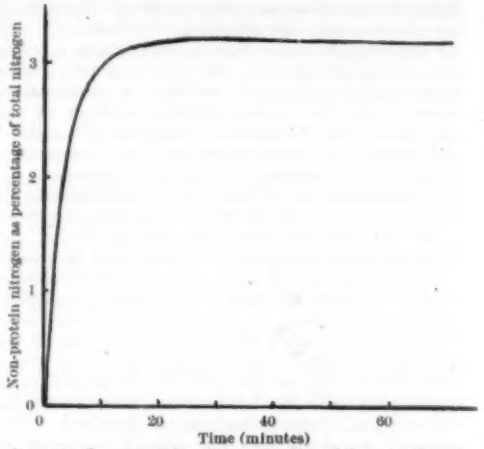
Department of Physiology,
University of Edinburgh.
Feb. 7.

[1] Nachmansohn, D., Hestrin, S., and Voripaieff, H., *J. Biol. Chem.*, **180**, 875 (1949).
[2] Hestrin, S., *J. Biol. Chem.*, **180**, 249 (1949).
[3] Feldberg, W., and Mann, T., *J. Physiol.*, **104**, 411 (1946).
[4] Kaplan, N., and Lipmann, F., *J. Biol. Chem.*, **174**, 37 (1948).
[5] Balfour, W., and Comline, R. (in preparation).

'Fibrino-Peptide': New Aspects of the Fibrinogen–Fibrin Transformation

A recent joint communication from workers at Cambridge and Leeds[1] reported that glycine-α-amino groups are liberated in the fibrinogen molecule when it is converted into fibrin, and strongly emphasized the proteolytic nature of the clotting reaction. The present communication is to report also that non-protein nitrogen is liberated through the splitting off, at the same time, of a portion of the fibrinogen molecule.

A number of workers in the past have investigated the nitrogen partition of the clotting system (for example, Jaques[2]); but their results were either inconclusive or indicated that all fibrinogen nitrogen was converted into fibrin nitrogen. Their method of approach, however, cannot be regarded as adequate because of the possibility of a second reaction product being occluded within the clot and estimated as fibrin. We have specially looked for such a substance in the following way. The fibrin gel was converted into a flocculent precipitate which facilitated the release of any non-protein reaction product into the supernatant; this was achieved by dissolving the clot in 1 per cent (w/v) monochloracetic acid and then precipitating the proteins with 7 per cent (w/v) trichloracetic acid, afterwards testing the supernatant for nitrogen by the micro-Kjeldahl method. The curve obtained is shown in the accompanying graph, in which the nitrogen content (per cent) of the supernatant is plotted against the time which had elapsed between the addition of thrombin to the fibrinogen and the dispersion of the gel by means of monochloracetic acid. This acid was found to be specially suitable as a dispersing agent, for, while it displays the same property towards fibrin as urea[3], dissolving the clot rapidly to produce a clear solution, it does not interfere with the nitrogen-estimation, and it does not inhibit the de-proteinizing action of trichloracetic acid. Highly purified bovine fibrinogen and pure thrombin (the latter kindly supplied by Prof. Seegers) were used in these experiments.



Increase of non-protein nitrogen in the fibrinogen – thrombin system at 20° C. and pH 6·8. The gel point is at about 1 min.

The asymptotic nature of the time-curve indicates that the liberation of non-protein nitrogen in the supernatant is not due to fibrinolysis, but is a characteristic feature of the enzymic action of thrombin on fibrinogen. (The asymptotic level of the curve is maintained for more than 18 hr., though it may be noted that the technique could provide an accurate means of measuring the rate of fibrinolysis.) The reaction does not stop with the onset of gelation but goes on to completion, when about 3–4 per cent of the total nitrogen appears as non-protein nitrogen. This implies that a pure fibrinogen preparation cannot contain more than 96–97 per cent clottable nitrogen if fibrin is recovered by an adequate method (for an attempt along such lines, see ref. 1).

Since it now appears that fibrin is not the sole reaction product during clotting, the question arises whence the non-protein nitrogen comes. Chromatographic evidence indicates that there appears in the supernatant a peptide which on acid hydrolysis yields a number of amino-acids, mainly those of the acidic and neutral type, and it contains neither tyrosine nor (as judged by its ultra-violet spectrum) tryptophan. It is clear that, on clotting with thrombin, a well-defined portion of the fibrinogen molecule is split off, which it is suggested should be called 'fibrino-peptide'. Every 100,000 weight of fibrinogen gives rise to *c.* 3–4,000 weight of fibrino-peptide.

$$\text{Fibrinogen} \xrightarrow{\text{Thrombin}} \text{Fibrin} + \text{Fibrino-peptide}$$

A standard method has now been worked out for the preparation of apparently pure fibrino-peptide, details of which will be published elsewhere.

From personal communication it is learnt that Dr. K. Bailey and Mr. F. R. Bettelheim, in parallel experiments at Cambridge, have also isolated a homogeneous peptide.

I should like to thank Prof. W. T. Astbury for his continued interest and Dr. W. R. Middlebrook for his valuable help in the chromatographic experiments.

L. Lorand

Department of Biomolecular Structure,
University of Leeds.
April 4.

[1] Bailey, K., Bettelheim, F. R., Lorand, L., and Middlebrook, W. R., *Nature*, **167**, 233 (1951).
[2] Jaques, L. B., *Biochem. J.*, **32**, 1181 (1938).
[3] Lorand, L., *Nature*, **166**, 694 (1950).

Influence of Light upon the Hatching of Winter-Eggs of the Fruit Tree Red Spider

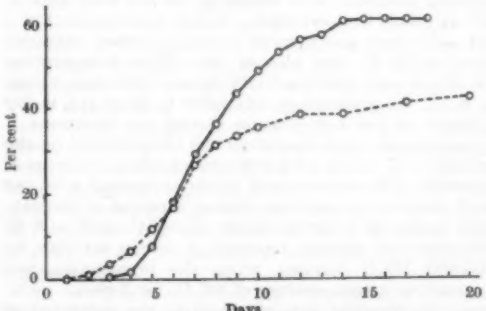
Recent work by Lees[1] and Miller[2] has shown that light is an important factor influencing the onset of diapause in the fruit tree red spider (*Metatetranychus ulmi* Koch = *Paratetranychus pilosus* C. and F.). In the course of investigations on this mite, which will be published in full detail elsewhere, I have found that the hatching of winter-eggs, too, is influenced by light.

The red winter-egg of the mite enters diapause at a very early stage of development. About the end of March development recommences. Hatching occurs three–four weeks after this breaking of diapause (Kuenen[3]).

In the first part of March 1950, about 1,700 winter-eggs on twigs were put in specially prepared Petri dishes, as described by Kuenen[3], in which humidity was kept constant by means of a saturated solution of ammonium chloride, giving a relative humidity of about 80 per cent. Some of the eggs were kept in the dark at 25° C., whereas others were exposed to daylight at the same temperature.

The hatched larvæ were caught in a ring of 'Tanglefoot' and counted daily. The result is represented in the accompanying graph. I have, as yet, no explanation for the anomalous result before the sixth day.

As the percentage hatched of different batches of winter-eggs of *M. ulmi* shows considerable differences even under conditions of constant temperature and humidity, which differences may be to a small extent due to unavoidable errors in counting the eggs on the twigs, the same experiment was repeated with about ten batches of about five hundred eggs each, both in the dark and in daylight. The results are shown in Table 1. The evidence points clearly to a lowering of the percentage hatched in the dark.



Hatching of winter-eggs of *Metatetranychus ulmi* Koch: ———, daylight (987 eggs); – – – –, dark (734 eggs)

Table 1

Daylight		Dark	
No. of eggs	Percentage hatched	No. of eggs	Percentage hatched
695	58	587	23
545	59	945	30
648	68	709	46
340	75	786	59
616	76	612	61
391	76	850	63
753	79	280	71
408	80	298	71
432	92	422	80
647	95	—	—
—— +	—	—— +	—
5,475	75 (mean)	5,189	52 (mean)

Some non-hatched eggs from the experiment in the dark after two months were put in lactophenol under a cover-slip on an object-slide. By gently pressing the cover-slip, it was possible to break the egg-shell without damaging the contents. Inspection showed that a great number of these non-hatched eggs contained what seemed to be fully developed larvæ.

The hatched larvæ show a strong positive phototaxis. This could be shown with the following simple device. Petri dishes with eggs, as described above, were put in boxes of which one side was left open. Counts were made on the half of each dish on the side of the light and on the opposite side (Table 2).

Table 2

Light source		No. of eggs hatched	Percentage of eggs	
			Light side	Dark side
Continuous artificial	exp. *a*	150	95	5
	exp. *b*	265	97	3
Daylight:	exp. *a*	238	89	11
,,	exp. *b*	350	90	10

Hence, in our experiment, the greater part of the eggs hatched during daylight. As day and night at the end of March are about equal in length, in the case of continuous hatching we would expect 50 per cent of the larvæ to appear during the night, half of which (25 per cent) would be found in the dark side of the dish. Of the larvæ appearing in daylight, *c.* 4 per cent would go to the dark side (cf. Table 2), which makes 2 per cent of the total number, so that in all 25 + 2 = 27 per cent would be expected in the dark side, whereas we find only about 10 per cent. It is clear that about 86 per cent of the larvæ must have hatched during daylight.

In view of these facts, it seems likely that light provides a stimulus to the fully developed embryo to break the egg-shell. The smaller percentage hatched of winter-eggs kept in the dark might accordingly be explained by assuming that at the critical moment they fail to hatch through lack of sufficient stimulus to do so, although the development of the embryo is undisturbed.

A feature of the egg is its dark red colour, which is due to a pigment in the yolk. If the photosensitivity described is due to the red pigment, we

would expect colour sensitivity in the hatching experiments. In a preliminary experiment, winter-eggs were put in boxes covered with colour-filters. The results are shown in Table 3. A preference for the shorter wave-lengths is apparent, which may indicate that the red pigment indeed plays a part in the processes described. Though accurate quantities of light were not measured, it was obvious that the blue filters absorbed more light than the other filters. The differences are therefore probably not due to quantitative responses to light.

Table 3

Colour	No. of eggs	Percentage hatched
Dark blue	880	83
Blue	380	95
Green	842	67
Yellow	915	70
Orange	1,277	57
Red	1,430	62

I am indebted to Prof. D. J. Kuenen, under whose guidance the experiments were carried out; to the board of directors of N.V. Organon-Oss, for permission to publish this note; and to Mrs. E. H. Hueck-v.d. Plas, Miss E. Draafsel and Miss L. G. Vroom, for their assistance.

H. J. Hueck

Laboratory of Entomology,
N.V. Organon, Leyden,
and
Department of Zoology,
University of Leyden.
Jan. 13.

[1] Lees, A. D., *Nature*, **166**, 874 (1950).
[2] Miller, L. W., *Nature*, **166**, 875 (1950).
[3] Kuenen, D. J., *Tijdschr. Pl. Ziekt.*, **52**, 69 (1946).

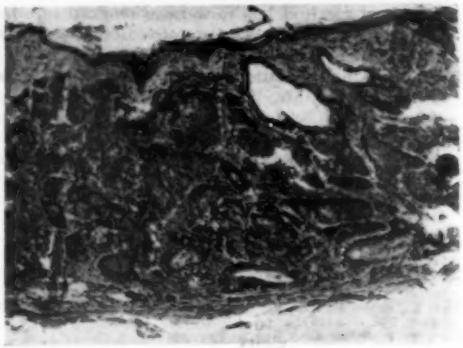
Epigastric Gland of *Tarsius*

The recent death of the adult male and last survivor of the three Philippine tarsiers (*Tarsius carbonarius*) lately in the Zoological Society's menagerie has enabled me to determine the existence of a specialized cutaneous gland hitherto unknown. The only special glands of integumental origin so far known in *Tarsius* are the circumanal glands and those associated with the touch-pads of the manus and pes[1].

The gland in question is situated in the median line of the epigastric region, extending over a distance of 16 mm. from the xiphisternal notch anteriorly towards the umbilicus. The overlying skin is nude over a narrow pyriform area, with the constricted end cranially, and having a maximum breadth posteriorly of 5 mm. The surface is marked with pits whence a brownish-red waxy secretion exudes, much resembling, if not identical with, that secreted by the circumanal glands.

The gland appears to be confined to the male, as I can detect nothing at this site in females. I have confirmed its presence in an adult male Bornean tarsier (*T. borneanus*).

The accompanying photomicrograph is from a vertical section through the skin and subjacent gland, taken transversely to its long axis. The section was stained with Masson, and shows the complete absence of hair-follicles over the glandular area. The glandular tissue is shown to be composed of densely aggregated lobules each made up of groups of acini of modified



(× 50)

sebaceous type, opening into short wide ducts leading to the exterior.

The site of the gland seems to be unique among Primates, where median glands are typically found on the sternal region, for example, in the orang[2] and drill[3].

A more detailed account is being prepared for publication elsewhere. Acknowledgment is made to the scientific director of the Zoological Society, Dr. E. Hindle, for permission to publish this note, and to Messrs. Ilford, Ltd., for the photomicrograph.

W. C. Osman Hill

Zoological Society of London,
Regent's Park,
London, N.W.8.
Feb. 23.

[1] Schaffer, F., "Die Hautdrüsenorgane der Säugetiere" (1940).
[2] Schultz, A. H., *J. Mammal.*, **2**, 194 (1921).
[3] Hill, W. C. O., *Nature*, **153**, 199 (1944).

Observations on the Type *A* Toxin of *Clostridium botulinum*

The recent communication by Wentzel, Sterne and Polson[1] makes it desirable to record some supplementary observations made in the chemical investigation of a number of toxins, especially that produced by *Clostridium botulinum* Type *A*. In the present experiments, the toxicity was determined by intraperitoneal injection into white mice of 20 gm. weight.

In the determination of the activity of the preparations, higher values (by about 10 per cent) were obtained consistently with gelatine-dipotassium hydrogen phosphate than with acetate buffer as diluting medium, after standing for one hour (pH = 6·8 at room temperature). When working at 8° C., not only were much more constant values obtained than at 25° C., but also at the higher temperature 40–50 per cent lower activity figures were found than at 8° C. It is therefore advisable to keep the buffer solution at low temperature during the titrations.

In general, the influence of the temperature on the stability of toxin preparations appears to be considerable. A concentrated solution showed a 50 per cent decrease in activity during a period of twenty-four hours at a temperature of 34° C. (pH = 6·8). Abrams[2] has already reported a fall in activity by 100,000 *MLD* (mouse), when the preparation was exposed to a temperature of 60° C. for 5 min.; complete inactivation was observed in the same period of time at 80° C. (pH 5).

The dependence on *p*H of the stability of the toxin has also been determined accurately; so far, it has only been stated[2] that above *p*H 7·0 the toxin is rapidly destroyed. It has been found that a *p*H of 7·5 causes a loss of activity of 100,000 *MLD* in 10 min., and at *p*H 8·2 a corresponding decrease by 250,000 *MLD* (at room temperature).

In contradistinction to Lamanna's[3] results on crystalline toxin, no influence of cupric ions (5 per cent cupric sulphate) on the activity of a concentrate was observed; also silver ions were without any adverse effect. Only mercuric salts (potassium iodomercurate) caused inactivation, when applied in concentrations of 1·2 per cent.

Pepsin does not decrease the activity of a toxin concentrate, as was to be expected from the well-known high oral toxicity of the toxin. A considerable increase in amino-nitrogen, however, was observed in the pepsin experiments; this may be due to the attack of the enzyme on impurities of protein character, which accompanied the toxin in the preparation used.

URIEL LITTAUER

Weizmann Institute of Science,
Rehovoth, Israel.
Feb. 8.

[1] Wentzel, Sterne and Polson, *Nature*, **166**, 739 (1950).
[2] Abrams, Kegeles and Hottle, *J. Biol. Chem.*, **164**, 63 (1946).
[3] Lamanna, Eklund and McElroy, *J. Bact.*, **52**, 1 (1946).

Identity of Frequentic Acid and Citromycetin

A WEAKLY antibacterial metabolic product of the moulds *Penicillium frequentans* Westling and *P. vesiculosum* Bainier has recently been described[1] and named frequentic acid. It was said to be yellow in colour and to give a deep green colour with ferric chloride; in these properties it is similar to citromycetin[2], $C_{14}H_{16}O_7.2H_2O$ (m.p. 285° C., dec.), a well-known metabolic product of *P. frequentans*. Though apparently differing in other published physical and chemical properties, for example, empirical formula $(C_5H_8O_3)_n$, melting point (155° C.), and stability towards hydrolytic reagents, it seemed possible to us that frequentic acid and citromycetin were identical. Further investigation has confirmed that this is so.

The Sir William Dunn School of Pathology, Oxford, kindly supplied us with a sample of frequentic acid and with cultures of moulds from which it had been obtained. These included two strains attributed to *P. frequentans* and one attributed to *P. vesiculosum* (believed to be NCTC 3567).

Following recrystallization from ethanol, the crystals of frequentic acid, when dried at 100° C., no longer melted with effervescence at 155° C., but decomposed at 290–300° C. with considerable previous blackening; found (on a sample dried *in vacuo* over phosphorus pentoxide for two days at 100° C.) C = 57·6, H = 3·6 per cent; (on a sample dried *in vacuo* at 150° C.) C = 57·9, H = 3·6 per cent; calculated for $C_{14}H_{16}O_7$, C = 57·9, H = 3·5 per cent. The equivalent weight of an air-dried sample of frequentic acid was found by potentiometric titration to be 162; calculated for $C_{14}H_{16}O_7.2H_2O$, 163 (dibasic acid).

An authentic specimen of citromycetin obtained from Dr. G. G. Freeman darkened at 260° C. and decomposed at 290–300° C. A mixed melting point determination with frequentic acid showed the same behaviour, although this cannot be taken as a reliable indication of the identity of the two specimens in view of the extensive decomposition which takes place. However, the infra-red absorption spectra of the two materials in the 3–14 μ region were identical.

Both frequentic acid and citromycetin gave an orange solution showing a green fluorescence with concentrated sulphuric acid, and both reduced ammoniacal silver nitrate rapidly in the cold. On boiling frequentic acid with 2*N* sulphuric acid for eight hours, it was converted into citromycin (m.p. 290° C., with previous blackening), giving an intense brown colour with ferric chloride. Frequentic acid was rapidly decomposed on boiling with 3*N* sodium hydroxide solution.

Dr. G. H. Spray (Department of Clinical Medicine, Oxford) has compared for us the antibacterial activities of citromycetin and a sample of frequentic acid which he had prepared in the autumn of 1946. In a cylinder plate assay with *Staphylococcus aureus*, 0·5 per cent solutions in *p*H 7·3 phosphate buffer gave inhibition zones of 25 mm. and 26 mm. mean diameter respectively.

The three moulds from which frequentic acid has been obtained all proved to be typical strains of *P. frequentans* Westling. The strain attributed to *P. vesiculosum* in no way agreed with Bainier's original description; in fact, the status of this specific name has recently been questioned[3]. All these citromycetin-producing strains of *P. frequentans*, together with others we have examined, are quite distinct in colony characteristics from those strains of the species from which another antibiotic, frequentin, has recently been obtained[4].

The foregoing evidence shows that frequentic acid and citromycetin are identical in their chemical and biological properties.

We are indebted to Drs. Weiler and Strauss, Oxford, and to Mr. W. Brown for the microanalyses, and to Mr. H. A. Willis and the directors of I.C.I. Plastics Division for the use of infra-red facilities.

JOHN FREDERICK GROVE
P. W. BRIAN

Butterwick Research Laboratories,
Imperial Chemical Industries, Ltd.,
Welwyn, Herts.
Feb. 8.

[1] Florey, H. W., *et al.*, "Antibiotics" (Oxford, 1949).
[2] Hetherington, A. C., and Raistrick, H., *Phil. Trans.*, B, **220**, 269 (1931).
[3] Raper, K. B., and Thom, C., "A Manual of the Penicillia" (London, 1949).
[4] Curtis, P. J., Hemming, H. G., and Smith, W. K., *Nature*, **167**, 557 (1951).

A Cross-Reaction in Resistance to Antibiotics

IN the course of routine laboratory work on sensitivity to antibiotics, a type of 'cross-reaction' in the development of resistance to them has been observed.

Case 1. A boy aged two years with an obstruction of the right tear duct was treated with distaquane-penicillin, 300,000 u./day for fifteen days. An eye swab was then taken and a blood-agar culture made from it. Three colonies grew and were identified as a *Staphylococcus aureus*. One of these was sub-cultured on blood agar and examined for antibiotic sensitivity by the paper disk method[1]. Four standard anti-

biotics are used as a routine procedure in this laboratory, namely, penicillin, streptomycin, chloromycetin and aureomycin. The following inhibited zones, measured from the edge of the disk, resulted:

Penicillin	5 mm.	Chloromycetin	7 mm.
Streptomycin	10 mm.	Aureomycin	7 mm.

However, in the aureomycin zone there appeared a light growth of minute colonies of the nature of *L*-forms of staphylococcus. These were sub-cultured as above and examined for antibiotic sensitivity as before. The following zone measurements were found:

Penicillin	—	Chloromycetin	7 mm.
Streptomycin	10 mm.	Aureomycin	7 mm.

Here again the light growth of *L*-forms was noticed in the aureomycin zone.

These results were reproduced several times and possibilities of false effects were eliminated. Microscopically there were no observable morphological or Gram-staining changes demonstrable.

It appeared, therefore, that a variation occurs with this organism in the presence of aureomycin, which results in the appearance of *L*-forms, and these are totally resistant to the action of penicillin, although the original organisms of the single colony dealt with were moderately sensitive to the action of that antibiotic.

Case 2. A child aged nine months had a history of six months of eczema on the right ear and legs. Treatment with penicillin (100,000 u. every 6 hr.) was continued for five days, after which a swab was taken and examined for organisms. A *Staphylococcus albus* was isolated and tested for antibiotic sensitivity, as above. The following zone measurements were obtained:

Penicillin	17 mm.	Chloromycetin	6 mm.
Streptomycin	9 mm.	Aureomycin	8 mm.

Again a light growth of minute *L*-forms appeared in the aureomycin zone. These were sub-cultured and examined for sensitivity, the following zones being obtained:

Penicillin	15 mm.	Chloromycetin	—
Streptomycin	12 mm.	Aureomycin	11 mm.

Here the light growth of *L*-forms persisted in the aureomycin zone, and as before these results were reproduced several times. It would appear in this case that the *L*-forms were totally resistant to chloromycetin.

Summarizing, in two juvenile patients with staphylococcal infections it was found, during the course of routine antibiotic investigation of the causative organisms, that *L*-forms appeared in the aureomycin zone, and these minute colonies when sub-cultured exhibited total resistance to penicillin and chloromycetin respectively, although the original organisms were moderately sensitive to them. Also, in both cases a recent history of penicillin therapy could be traced. Possibility of strain variation is eliminated, since all work was done from single colonies at the commencement.

As these results seem rather significant, we have reported them without delay.

F. Bergersen

Bacteriology Department,
Medical School,
University of Otago,
Dunedin, N.Z.
Jan. 23.

[1] Thomson, *J. Clin. Path.*, **3**, No. 2.

Antifungal Agents from the Bark of *Populus candicans*

In a recent communication, Grosjean[1] reported on the fungicidal activity of aqueous extracts from the bark of *Populus* species. In our laboratory the bark of *Populus candicans* has been studied in more detail. It was found to contain several compounds of low fungistatic activity such as pyrocatechol, salicin, saligenin and salicylic acid derivatives, whereas the test results revealed that substances of relatively high activity were also present. Two of these compounds were isolated as follows.

The fresh bark was extracted several times with boiling water. The aqueous extract was concentrated *in vacuo*, and extracted with ether. The ethereal extract was evaporated to dryness, and the residue was extracted several times with boiling benzene. The benzene extract was filtered under pressure through talcum venetum (purified by stirring with 10 per cent ethanol in benzene, washing with benzene and drying) and evaporated to dryness. The residue, a brown syrup, partly crystallized on standing in the refrigerator for several weeks. The crystals were filtered by suction, washed with carbon tetrachloride, and recrystallized several times from benzene. The white needles thus obtained were isolated with a yield of about 0·3 per cent calculated on the fresh bark (water content, 40 per cent) and melted at 104–105° C. The compound completely inhibited the growth of *Botrytis cinerea*, *Penicillium italicum*, *Aspergillus niger* and *Rhizopus nigricans* in the roll-culture test[2] at a concentration of 100 p.p.m., whereas in the slide germination test 250 p.p.m. were required to produce the same effect. The crystals gave a blue colour with ferric chloride in alcohol, and on hydrolysis with sodium ethanolate yielded benzyl alcohol and gentisic acid. Microanalysis: found: C, 68·72; H, 4·96; calculated for benzyl gentisate: C, 68·82; H, 4·95.

Benzyl gentisate, a compound which has not yet been described in the literature, could be synthesized by applying the general method of Gomberg and Buchler[3] for preparing benzyl esters. The compound did not depress the melting point of the isolated product and showed the same antifungal activity.

The remainder of the brown syrup was distilled at a pressure of 0·003 mm. mercury. A fraction distilling below 100° C. was distilled off, and the residue was dissolved in benzene. The solution was chromatographed under pressure through purified talcum venetum, and the fractions obtained were evaporated to dryness. In nearly all the residues a very small quantity of a white, microcrystalline material, insoluble in cold acetone, was present. The residues were combined, taken up in acetone, and filtered. The precipitate was recrystallized twice from acetone, yielding 6 mgm. of fatty and transparent silver-white plates.

This product contained no nitrogen, sulphur or halogens. The elementary analysis gave: C, 84·40; H, 14·18. Molecular weight determinations in camphor yielded values varying between 413 and 481. The crystals melted in the range 57–61° C., and became strongly transparent prior to melting. The solubility properties, estimated by microscopic observation, were as follows: water, ethylacetate, cold acetone—insoluble; petroleum ether—slightly soluble; ether—soluble; benzene, chloroform and hot acetone—very soluble. The substance floated on water and sank in benzene (density between 0·88 and 1). It was neutral, the ferric chloride reaction

was negative, and the reaction with tetranitromethane was weakly positive. In the slide germination test, the substance completely inhibited the spore germination of *Penicillium italicum* at a concentration of 45 p.p.m.

The available data indicate that the compound is not entirely pure and apparently contains an unsaturated hydrocarbon, probably of olefinic character, with thirty to thirty-five carbon atoms. The oxygen content of 1·42 per cent indicated by the microanalysis is most probably due to partial oxidation. A hydrocarbon isolated by Naudin[4] from *Matricaria chamomilla* was also found to contain 1·5–1·8 per cent of oxygen, whereas Francis, Watkins and Wallington[5] showed that paraffin wax fractions are partially oxidized when air is introduced at 100° C. The substance appeared to be rather unstable. Fungistatically active fractions containing the substance decrease in activity on standing, notably when dissolved in benzene, and resinify at temperatures higher than 100° C. with complete loss of activity.

For purposes of comparison, the *cis*-olefine with thirty-five carbon atoms, pentatriacontene-17, was synthesized from stearic acid by the method of Grün *et al.*[6]. This compound consists of transparent silver-white plates and possesses physical properties very similar to those of the isolated product; it is, however, fungistatically inactive.

These investigations are being continued.

H. L. Klöpping
G. J. M. van der Kerk
Institute for Organic Chemistry T.N.O.,
Utrecht. Feb. 3.

[1] Grosjean, J., *Nature*, **165**, 853 (1950).
[2] Manten, A., Klöpping, H. L., and van der Kerk, G. J. M., "Ant. van Leeuwenhoek", **16**, 282 (1950).
[3] Gomberg, M., and Buchler, C. C., *J. Amer. Chem. Soc.*, **42**, 2063 (1920).
[4] Naudin, E., *Bull. Soc. Chim. France*, 485 (1884).
[5] Francis, F., Watkins, C. M., and Wallington, R. W., *J. Chem. Soc.*, **121**, 2804 (1922).
[6] Grün, A., Ulbrich, E., and Krczil, F., *Z. angew. Chem.*, **39**, 424 (1926).

Calculation of the Digestibility of the Protein in Silage

It has been shown by Barnett and Miller[1] that the relationship between the soluble nitrogen content (N_s) and the total nitrogen content (N_d) of dried samples of grass silage can be represented by the formula: $N_s/N_d = 0{\cdot}854 - 0{\cdot}100\,p\mathrm{H} \pm 0{\cdot}012$. As the quality of silage is related to its pH, it seemed desirable to estimate the digestibility of the protein in dried silage by the pepsin method of Wedemeyer[2]. This method has fallen into disuse as it is stated to give results which are too high, but, so far as we are aware, no critical study of the method in connexion with silage exists. A study of the protein digestibility of the samples previously examined (about seventy in number) for their soluble nitrogen content revealed that a direct relationship existed between the soluble nitrogen content and the digestible protein content (N_p)/(N_d). This relationship is given by the formula $N_p/N_d = 33{\cdot}4 + 0{\cdot}78\ N_s/N_d \pm 0{\cdot}07$. It is possible then, with regard to dried grass silage, to portray the nitrogen state, so to speak, as in Fig. 1, the results there being shown on a percentage basis. As the direct determination of N_p/N_d involves a pepsin digestion which lasts forty-eight hours, whereas the corresponding operation of washing the dried silage to determine N_s/N_d takes only forty minutes, the time saved by this method of approach is obvious.

Watson[3] has shown that the amount of digestible crude protein in silage can be calculated from the

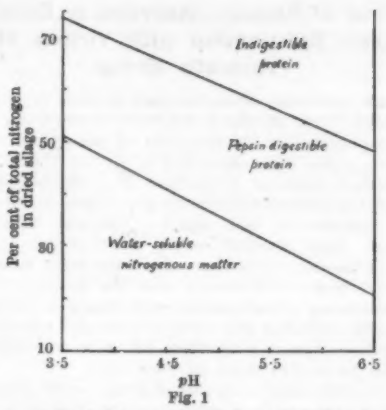


Fig. 1

formula, Dig.C.P. = 0·8179CP − 2·415; but he stresses that this formula applies only to well-made silage. Dijkstra[4] has evolved three formulæ for the calculation of the digestible crude protein content of silage applicable to silage of three main quality groups. In Fig. 2 are shown the results obtained by calculating the digestible crude protein contents according to the methods of Watson, Dijkstra and

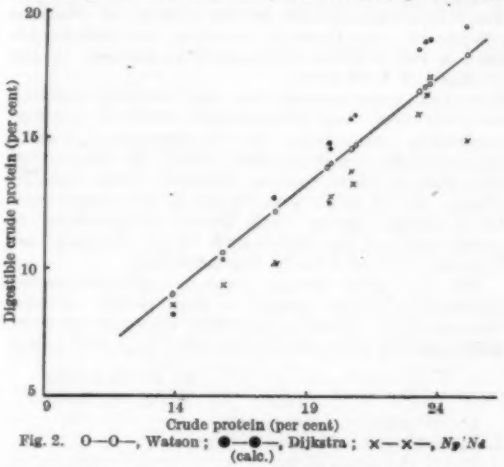


Fig. 2. O—O—, Watson; ●—●—, Dijkstra; ×—×—, N_p/N_d (calc.)

our formula for N_p/N_d. Each point in this graph represents the average result obtained by the examination of twelve or more samples from a given tower or pit. Among other things it will be noted that, in general, the results obtained by the third method are lower than those obtained by either Watson's or Dijkstra's method.

Preliminary studies indicate that the results obtainable in the laboratory are reproducible in feeding trials, and a fuller account of this work will appear elsewhere at a later date.

A. John G. Barnett
T. B. Miller
Division of Agricultural Biochemistry,
Department of Biological Chemistry,
University of Aberdeen.

[1] Barnett, A. J. G., and Miller, T. B., *J. Agric. Sci.*, **40**, 50 (1950).
[2] Wedemeyer, K., *Landw. VersSta.*, **51**, 375 (1899).
[3] Watson, S. J., "Science and Practice of Conservation: Grass and Forage Crops", 508 (Pub. by *Fertil. and Feed.-St. J.*, 1939).
[4] Dijkstra, N. D., *Versl. Landbouwk. Onderzoek.*, No. 55, 10 (1949).

Virus of Enzootic Abortion in Ewes: Antigenic Relationship with Viruses of the Psittacosis Group

Large numbers of elementary bodies were found by Stamp *et al.*[1] in the fœtal membranes from sheep after experimental transmission of enzootic abortion in ewes; these were described as having the morphological and staining properties of a rickettsia or a virus of the psittacosis-lymphogranuloma group. The exact nature of the agent remained uncertain, although later studies[2] on its development in the chorio-allantoic membrane of fertile eggs suggested that the latter relationship was the more probable. The following experiments were made in order to determine whether the virus of enzootic abortion in ewes has antigenic properties which would define its position from this point of view.

After cultivation in developing hens' eggs, we obtained rich yields of elementary bodies in yolk-sac suspensions which were partially purified by differential centrifugation and heated in a boiling-water bath for twenty minutes.

Using the complement-fixation technique, such a heated suspension was tested against serial dilutions of human sera from cases of psittacosis and lymphogranuloma venereum; standard heated preparations of these last-named viruses were also included. It was found that enzootic abortion virus, at dilutions comparable with those of the other two suspensions, gave a full degree of complement fixation in the presence of both sera.

Further tests showed that the antibody reacting with all three virus preparations could be removed completely from both sera by absorption with a heated suspension of the new virus[3]. Mr. Stamp has also sent us three samples of serum from infected sheep; all of them were found to fix complement to a similar extent with heated preparations of psittacosis and the homologous virus. In each case a serum titre of 1 in 64 was recorded.

The heat-stable antigen common to the psittacosis-lymphogranuloma viruses is thus readily demonstrated in the virus of enzootic abortion of ewes, which should therefore be classified with this group.

C. F. Barwell
L. W. J. Bishop

Department of Bacteriology,
London Hospital Medical College,
London, E.1.
Feb. 8.

[1] Stamp, J. T., McEwen, A. D., Watt, J. A. A., and Nisbet, D. I., *Vet. Rec.*, **62**, 251 (1949).
[2] Stamp, J. T. (personal communication).
[3] Bedson, S. P., Barwell, C. F., King, E. J., and Bishop, L. W. J., *J. Clin. Path.*, **2**, 241 (1949).

Blood Groups of Brazilian Indians

Blood-samples from 73 pure-bred Brazilian Indians in the interior of the Mato Grosso, Brazil, have been examined by us for the presence of the antigens *A*, *B*, *C*, *c*, *D*, *E*, *e*, *M*, *N*, *S*, *P*, Lutheran, Kell and Duffy (Fy^a). An account of this work will be published elsewhere in full.

The point of special interest is that all these Brazilian Indian bloods were Duffy-negative.

The blood-group antigen Duffy or Fy^a was discovered by Cutbush, Mollison and Parkin[1], who found the corresponding antibody in the serum of a man immunized by transfusion. The most complete published figures, those of Race and Sanger[2], show that Fy^a is present in the blood of 65 per cent of English people. Cutbush and Mollison[3] have found it in 91 per cent of people from north-west Pakistan; Miller, Rosenfield and Vogel[4] in 99 per cent of Chinese and in 26 per cent of American Negroes; and Hartmann and Brendemoen[5] in 97 per cent of Norwegian Lapps. The fact that all Brazilian Indians so far tested should lack this antigen is a fact which may prove to be of considerable anthropological importance.

This work was made possible by the generosity of the Brazilian Government, through the Instituto Oswaldo Cruz, the Brasil Central Foundation, the Serviço do Proteção dos Indios, and the Brazilian Air Force, which provided transport. The extensive local knowledge and the exact personal records made over many years by the Brasil Central Foundation and the Serviço dos Indios assured the racial purity and the genealogy of our subjects.

The anti-Fy^a serum used was supplied by the kindness of Dr. P. L. Mollison. The antibody exists only in the 'incomplete' form and was used by the Coombs anti-human-globulin technique. It gave strong positive reactions with 8 out of 16 white Brazilian controls (Portuguese, English, French and German).

We should like to thank Drs. O. J. Brendemoen, O. Hartmann, E. B. Miller, R. E. Rosenfield and P. Vogel for allowing us to quote their unpublished results.

A. M. Pantin
P. C. Junqueira

Department of Hæmatology,
Instituto Oswaldo Cruz,
Rio de Janeiro. Dec. 11.

[1] Cutbush, Marie, Mollison, P. L., and Parkin, Dorothy M., *Nature*, **165**, 188 (1950).
[2] Race, R. R., and Sanger, Ruth, "Blood Groups in Man", 206 (Blackwell Scientific Publications, Oxford, 1950).
[3] Cutbush, Marie, and Mollison, P. L., *Heredity*, **4**, 383 (1950).
[4] Miller, E. B., Rosenfield, R. E., and Vogel, P. (personal communication, 1950).
[5] Hartmann, O., and Brendemoen, O. J. (personal communication, 1950).

A Serious Sugar-cane Disease in British Guiana

A sugar-cane disease with internal and external symptoms like 'leaf-scald'[1] (*Xanthomonas albilineans*) is widespread throughout British Guiana and is causing serious losses. Varieties *B*.34104 and *D*.14/34, which account respectively for 70 and 15 per cent of plantings, are affected both as plants and ratoons. Isolations of the causal organism have been made and successfully re-inoculated.

A colony-wide survey to provide information on which control policies can be based is in progress, and a trial to determine possible resistant varieties has been laid down. Until such varieties are available, the elimination of infected areas and the adoption of measures to minimize dissemination should hold the disease in check.

P. B. Hutchinson
W. T. Dale

Imperial College of Tropical Agriculture,
Trinidad, B.W.I.
Feb. 12.

[1] See Arruda, S. C., and Amaral, J. F. do, *Phytopath.*, **35**, 135 (1945).

FORTHCOMING EVENTS

Tuesday, June 19—Wednesday, June 20

INSTITUTE OF PHYSICS, ELECTRON MICROSCOPY GROUP (in the Department of Natural Philosophy, The University, St. Andrews).—Conference.

Wednesday, June 20

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

Wednesday, June 20—Thursday, June 21

SOCIETY FOR THE STUDY OF FERTILITY (at Girton College, Cambridge).—Conference.

Thursday, June 21

INSTITUTE OF PETROLEUM (at the Royal Institution, 21 Albemarle Street, London, W.1), at 4.30 p.m.—Dr. Robert E. Wilson: "Competitive and Co-operative Research in the American Petroleum Industry" (Cadman Memorial Lecture).

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. E. K. Rideal, F.R.S.: "Reactions in Monolayers" (Bakerian Lecture).

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Messrs. R. Cornthwaite and F. Juretic: "Sinking of Irwin Shaft at the Roan Antelope Copper Mine"; Messrs. E. K. McDermott and P. Wilken: "Some Notes on a Simplified Method of Laying Out Diamond Drill Holes for Stoping".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT IN CHEMISTRY, and an ASSISTANT IN THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (June 22).

ENGINEERS and MATHEMATICIANS (Senior Scientific Officer grade) at the Royal Aircraft Establishment, Farnborough, Hants, for theoretical work on aircraft flutter as affecting aircraft design—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.307/51A (June 22).

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (June 22).

SENIOR ASSISTANT (Scientific)—The Secretary, British Society for Research in Agricultural Engineering, Scottish Machinery Testing Station, Mid Calder, Midlothian (June 22).

AREA SCIENTISTS (with good honours degree and sound experience in fuel technology and coal analysis), one in Cannock and one in Tamworth, Warwickshire—The Divisional Establishment Officer, National Coal Board, West Midlands Division, Himley Hall, Dudley, Worcs. (June 23).

HEAD OF THE DEPARTMENT OF SCIENCE, County Technical College, Wednesbury—The Director of Education and Clerk to the Governors, Dept. F.E., County Education Offices, Stafford (June 23).

LECTURER IN PHYSICAL CHEMISTRY, and a TEACHER IN THE DEPARTMENT OF CHEMISTRY AND BIOLOGY, at the Leeds College of Technology—The Chief Education Officer, Education Department, Leeds 1 (June 23).

PHYSICIST in the Physics Department, Bristol General Hospital—The Secretary to the Board, Royal Infirmary Branch, Bristol 2 (June 23).

LECTURER (temporary) IN THEORETICAL PHYSICS or HIGH FREQUENCY PHYSICS—The Secretary, Queen's University, Belfast (June 27).

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (June 29).

FISHERY OFFICER in the Ministry of Commerce—The Secretary, Civil Service Commission, Stormont, Belfast (June 29).

ARMOURERS AND BRASIERS' COMPANY RESEARCH FELLOWSHIP IN METALLURGY—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (June 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF GEOLOGY—The Registrar, The University, Liverpool (June 30).

ASSISTANT LECTURER (probationary) IN METALLURGY—The Registrar, University College, Singleton Park, Swansea (June 30).

ASSISTANT LECTURER IN PHYSICS—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1 (June 30).

CHEMIST or SENIOR CHEMIST, CHEMIST or ASSISTANT CHEMIST, in the Fats Research Laboratory, Department of Scientific and Industrial Research, Wellington—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (June 30).

LECTURER IN RADIOCHEMISTRY—The Secretary, University of Durham, 38 North Bailey, Durham (June 30).

PHYSICIST to undertake research on textile materials and processes, and a LIBRARIAN to take charge of the Association's library—The Secretary, Hosiery and Allied Trades Research Association, Thorneywood House, 4 First Avenue, Sherwood Rise, Nottingham (June 30).

RESEARCH PHYSICIST who will be concerned with vacuum spectroscopy—The Professor of Physics, The University, Reading (June 30).

SENIOR ASSISTANT PHYSICIST for duties mainly in the Radiotherapy Department—The Clerk to the Governors, St. Thomas's Hospital, London, S.E.1 (June 30).

UNIVERSITY ASSISTANT LECTURER IN MATHEMATICS—Dr. R. A. Lyttleton, St. John's College, Cambridge (June 30).

STATISTICIAN, or MATHEMATICIAN with a knowledge of statistics, to work on problems connected with load estimation and the effect of weather on load—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting Ref. AE/178 (July 2).

ELECTRICAL ENGINEERS and PHYSICISTS (Senior Scientific Officer or Scientific Officer grade) at Ministry of Supply research and development establishments near London: ELECTRICAL ENGINEERS (qualified in radio communications, with an interest in the engineering of development prototypes, PHYSICIST (with experience in electronic circuitry problems for measurement of high-speed transients), EXPERIMENTAL PHYSICIST (with experience of metallurgical techniques), PHYSICIST (with interest in application of electronic methods to optical instrumentation techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.162/51A (July 3).

JUNIOR LECTURER IN PHYSIOLOGY—The School Secretary, Middlesex Hospital Medical School, London, W.1 (July 5).

LECTURER IN CLINICAL CHEMISTRY—The Secretary, The University, Edinburgh (July 7).

PRINCIPAL SCIENTIFIC OFFICER (with university degree with first- or second-class honours, chemistry as a principal subject, or an equivalent qualification; or possessing high professional attainments) to take charge of a section dealing with a group of products, in the Colonial Products Advisory Bureau (Plant and Animal), London, S.W.7—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.393/51A (July 7).

PROFESSIONAL OFFICER IN THE MALARIA AND BILHARZIA RESEARCH LABORATORY in Salisbury—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 7).

RESEARCH FELLOWSHIP IN GEOLOGY—The Deputy Secretary, The University, Edmund Street, Birmingham 3 (July 7).

TECHNICAL SECRETARY (with an honours university degree in science with chemistry or fuel technology as major subjects, or an honours degree in technical science in fuel technology or chemistry, or equivalent qualifications), Coal Research Section, North Ryde, Sydney, N.S.W.—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3418 (July 7).

DEMONSTRATOR IN AGRICULTURAL BACTERIOLOGY, and a DEMONSTRATOR IN AGRICULTURAL ZOOLOGY—The Registrar, The University, Leeds 2 (July 9).

ENGINEER I at a Ministry of Supply establishment in south-east England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.230/51A (July 13).

LECTURER (Grade II or Grade III) IN PURE MATHEMATICS—The Deputy Secretary, The University, Edmund Street, Birmingham 3 (July 15).

CHEMISTS (Senior Scientific Officer, Scientific Officer, Senior Experimental Officer, Experimental Officer, and Assistant Experimental Officer grades) at the Ministry of Supply Radiochemical Centre, Amersham, Bucks., to be concerned with the synthesis of compounds labelled with radioactive isotopes, particularly Carbon-14, and with allied research problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.365/51A (July 21).

RESEARCH FELLOWSHIP IN THE DEPARTMENT OF MATHEMATICAL PHYSICS—The Deputy Secretary, The University, Edmund Street, Birmingham 3 (July 25).

CHAIR OF PHILOSOPHY in the Faculty of Theology, Royal University, Malta—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

LECTURER IN ELECTRONIC ENGINEERING at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, July 31).

LECTURER IN THE DEPARTMENT OF GEOLOGY AND MINERALOGY, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, July 31).

CHAIR OF ANATOMY, and the CHAIR OF PHYSIOLOGY, in the newly established Faculty of Medicine for non-Europeans, University of Pietermaritzburg, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 1).

LECTURER IN MATHEMATICS at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

ASSISTANT LECTURER IN THE SCHOOL OF CHEMISTRY—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

DEMONSTRATOR IN GEOLOGY—The Finance Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7.

DEMONSTRATOR or JUNIOR LECTURER IN PHYSICS—The Professor of Physics, Carleton College, Ottawa, Ont., Canada.

DEVELOPMENT ENGINEER IN THE DEPARTMENT OF AERODYNAMICS—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks., endorsed 'Development Engineer'.

EXPERIMENTAL ASSISTANTS (B.Sc. standard) for help with general physical problems associated with gas utilization research problems in the gas industry, including field work—The Gas Research Board (BEC. 5014–6), The Abbey, Southend Road, Beckenham, Kent.

GRADUATE IN CHEMISTRY, PHYSICS, CHEMICAL or MECHANICAL ENGINEERING, as RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED PHYSICAL CHEMISTRY, to undertake, under supervision, a systematic investigation into the venting of gaseous explosions on a practical scale—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7.

HEAD OF THE DEPARTMENT OF HOP RESEARCH—The Registrar, Wye College, Wye, Ashford, Kent.

LECTURER or ASSISTANT LECTURER IN MICROBIOLOGY, an ASSISTANT LECTURER IN PHARMACEUTICAL CHEMISTRY, a LECTURER or ASSISTANT LECTURER IN PHYSIOLOGY AND PHARMACOLOGY or PHYSIOLOGY AND BIOCHEMISTRY, and an ASSISTANT LECTURER IN FOOD SCIENCE—The Secretary, Royal Technical College, Glasgow.

LECTURER IN THE DEPARTMENT OF HEATING AND VENTILATING—The Clerk to the Governors, National College for Heating, Ventilating, Refrigeration and Fan Engineering, Borough Polytechnic, Borough Road, London, S.E.1.

LECTURER IN PHYSIOLOGY—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

METALLURGIST, or PHYSICIST with research experience, to undertake study of grain boundary phenomena in metals, and a GRADUATE IN METALLURGY (research experience not essential)—The Research Manager, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

RESEARCH CHEMIST, for work offering a wide and original field to a graduate possessing bacteriological and/or biochemical qualifications, and an EXPERIENCED PHYSICIST, for research work connected with the fundamental physical properties of vegetable fibres—The Secretary, British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee.

RESEARCH SCHOLARSHIP awarded by the Institution of Heating and Ventilating Engineers—The Clerk to the Governors, National College for Heating, Ventilating, Refrigeration and Fan Engineering, Borough Polytechnic, Borough Road, London, S.E.1.

SENIOR PHYSICIST TO THE RADIOTHERAPY DEPARTMENT—The Group Secretary, Wolverhampton Hospital Management Committee, Royal Hospital, Wolverhampton.

WILLIAM NELSON HADEN SCHOLARSHIP for a course of advanced study or research in heating or air-conditioning during the academic year 1951–52—The Clerk to the Governors, National College for Heating, Ventilating, Refrigeration and Fan Engineering, Borough Polytechnic, Borough Road, London, S.E.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Introduction to a University. Pp. iii+47+iv. (Birmingham: The University, 1951.) [94

The Men on the Boards: a Study of the Composition of the Boards of Nationalised Industry. (Nationalised Industry Series, 4.) Pp. iii+22. (Claygate: Acton Society Trust, 1951.) 2s. [94

Women's Advisory Council on Solid Fuel. Seventh Annual Report, 1950. Pp. 16. (London: Women's Advisory Council on Solid Fuel, 1951.) [94

Department of Scientific and Industrial Research: Road Research Laboratory and Geological Survey and Museum. Sources of Road Aggregate in Great Britain. Second edition. Pp. iv+106. (London: H.M. Stationery Office, 1951.) 3s. net. [94

Empire Cotton Growing Corporation, 1921 to 1950. Pp. 44. (London: Empire Cotton Growing Corporation, 1951.) Free. [94

University of Birmingham. Report of the Vice-Chancellor and Principal to the Council for the Calendar Year 1950. Pp. 75+10 plates. (Birmingham: The University, 1951.) [94

Sir John Cass College. Report, Session 1949–50. Pp. 24. (London: Sir John Cass College, 1951.) [94

A Guide to the Collection of Gemstones in the Geological Museum. By Dr. W. F. P. McLintock. Third edition, revised by P. A. Sabine. Pp. viii+76. (London: H.M. Stationery Office, 1951.) 3s. net. [104

Report of the Conference on Electricity as an Aid to Productivity, 15th and 16th November 1950. Pp. 52. (London: Institution of Electrical Engineers, 1951.) 6s. [104

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences, No. 864, Vol. 243: The Evaluation of Integrals occurring in the Theory of Molecular Structure, Parts 1 and 2. By M. P. Barnett and C. A. Coulson. Pp. 221–249. (London: Cambridge University Press, 1951.) 6s. 6d. [104

International Association of University Professors and Lecturers. Communication 16: Report on Student Health Services. Pp. 62. (London: International Association of University Professors and Lecturers, 1950.) 1s. [104

Imperial Forestry Institute: University of Oxford. Twenty-sixth Annual Report, 1949–50. Pp. 27. (Oxford: Imperial Forestry Institute, 1951.) [104

The Association of Ants with Aphids and Coccids. By G. E. J. Nixon. Pp. 36. (London: Commonwealth Institute of Entomology, 1951.) 5s. [104

Department of Industry and Commerce: Meteorological Service. Geophysical Publications, Vol. 3, No. 3: The Development of a Method of Estimating and Forecasting Winds at 10,000 Feet over the North Atlantic. By H. H. Lamb. Pp. 8+6 plates. (Dublin: Stationery Office, 1951.) 5s. [104

British Standard 1121, Part 17: 1951, Methods for the Analysis of Iron and Steel, Part 17, Titanium in Permanent Magnet Alloys. Pp. 10. 2s. net. British Standard 1121, Part 18: 1951, Methods for the Analysis of Iron and Steel, Part 18, Chromium in Ferro-chromium. Pp. 6. 1s. net. British Standard 1701: 1950, Air Filters for Internal Combustion Engines and Compressors. Pp. 32. 4s. net. (London: British Standards Institution, 1950–1951.) [104

Colonial Office. Colonial Research Publication No. 10: Locust Research and Control, 1929–1950. By Dr. B. P. Uvarov. Pp. iv+68. (London: H.M. Stationery Office, 1951.) 5s. net. [104

National University of Ireland. Calendar for the Year 1950. Pp. x+291+916. (Dublin: National University of Ireland, 1951.) [104

University of Leeds. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing during the Session 1949–50. Pp. 44. (Leeds: The University, 1950.) [114

British Hat and Allied Feltmakers Research Association. Third Annual Report of the Director of Research for Year ending August 1950. Pp. 16. (Manchester: British Hat and Allied Feltmakers Research Association, 1951.) [114

Other Countries

Forest Research in India and Burma, 1947–48. Part 1: The Forest Research Institute. Pp. vi+133. (Delhi: Manager of Publications, 1950.) 6.2 rupees; 9s. 6d. [94

Berichte der Naturforschenden Gesellschaft zu Freiburg i. Br. Herausgegeben von Prof. Dr. M. Pfannenstiel. Band 40. Pp. 211. (Freiburg i. Br.: Naturforschende Gesellschaft, 1950.) [94

Proceedings of the American Philosophical Society. Vol. 95, No. 1: Problems of Development of Densely Settled Areas and Scientific Possibilities for Increasing the World's Food Supply. Pp. 91. (Philadelphia: American Philosophical Society, 1951.) 1 dollar. [94

Bulletin of the American Museum of Natural History. Vol. 96, Article 7: Genetics of Species Differences in the Morphology of the Male Genitalia of Xiphophorin Fishes. By Myron Gordon and Donn Eric Rosen. Pp. 409–464+plates 17–18. (New York: American Museum of Natural History, 1951.) 75 cents. [94

Fieldiana. Geology, Vol. 11, No. 2: Diplocaulus, a Study in Growth and Variation. By Everett Claire Olson. Pp. 55–154+7 plates. 1.75 dollars. Geology, Vol. 11, Nos. 3 and 4: Evolution and Classification of the Osteostraci, by Robert H. Denison; The Exoskeleton of Early Osteostraci, by Robert H. Denison. Pp. 155–218. 1 dollar. Zoology, Vol. 32, No. 7: Birds of the Acary Mountains, Southern British Guiana. By Emmet R. Blake. Pp. 417–474. 75 cents. (Chicago: Chicago Natural History Museum, 1950–1951.) [94

Bulletin of the Bingham Oceanographic Collection. Vol. 13, Article 1: Oxygen, Phosphate and Nitrate in the Atlantic Ocean. By Gordon A. Riley. Pp. 126. (New Haven, Conn.: Yale University, 1951.) 1.90 dollars. [94

Kansas Agricultural Experiment Station. Technical Bulletin 67: Cytogenetics of the Grouse Locust, *Apotettix eurycephalus* Hancock. By Robert K. Nabours and Florence M. Stebbins. Pp. 116. (Manhattan, Kans.: Kansas Agricultural Experiment Station, 1950.) [94

Canada: Department of Mines and Resources. Report of Mines, Forests and Scientific Services Branch for the Fiscal Year ended March 31, 1949. Pp. iii+18–134. (Ottawa: King's Printer, 1950.) [94

Canada. Annual Report of the Department of Mines and Technical Surveys for the Fiscal Year ended March 31, 1950. Pp. 112. (Ottawa: King's Printer, 1951.) 50 cents. [94

French Bibliographical Digest. No. 6, December. Science: Mathematics–Astronomy. Pp. iii+109. (New York: Cultural Division of the French Embassy, 1950.) [94

Training for Social Work: an International Survey. Pp. vi+246. (Lake Success, N.Y.: United Nations; London: H.M. Stationery Office, 1950.) 2 dollars: 15s. [94

Transactions of the American Philosophical Society. New Series, Vol. 40, Part 4: The Nalarayadavadanticarita (Adventures of King Nala and Davadanti), a Work in Old Gujarati. Edited and translated with a Grammatical Analysis and Glossary by Ernest Bender. Pp. 263–372. (Philadelphia: American Philosophical Society, 1951.) 2 dollars. [94

Caribbean Commission Central Secretariat. West Indian Conference, Fourth Session. Pp. vii+110. (Port of Spain, Trinidad: Printed by Guardian Commercial Printery, n.d.) [104

Istituto di Studi Adriatici. Memorie di biogeografia adriatica. Vol. I. Pp. iii+299. (Venezia: Istituto di Studi Adriatici, 1950.) [104

New Zealand: National Art Gallery and Dominion Museum. Report of the Board of Trustees for the Year ended 31st March 1950. Pp. 17. (Wellington: Government Printer, 1950.) 9d. [104

Memoirs of the India Meteorological Department. Vol. 28, Part 2: Winds at 10 kms. and above over India and its Neighbourhood. By S. P. Venkiteshwaran. Pp. 55–120+78 plates. 23.8 rupees; 36s. Vol. 28, Part 4: Notes on Analysis of Weather of India and Neighbourhood. By S. L. Malurkar. Pp. iv+139–216. 5.2 rupees; 8s. (Delhi: Manager of Publications, 1950.) [104

Pontificiæ Academiæ Scientiarum. Scripta Varia, 8: La strutturazione psicologica del linguaggio studiata mediante l'analisi elettroacustica. Per Agostino Gemelli. Pp. 53+30 plates. (Vatican City: Pontificia Academia Scientiarum, 1950.). [104

An Illustrated Guide to the Freshwater Fishes of the Sudan. By H. Sandon. Pp. 61+14 plates. (Khartoum: *Sudan Notes and Records*, 1950.) [104

Survey of India. Technical Report, 1948–49, Part 3: Geodetic Work. Pp. xiv+155+35 charts. (Dehra Dun: Survey of India, 1950.) 4 rupees; 6s. [104

Federal Security Agency: Office of Education. Annual Report of the Federal Security Agency, 1950. Pp. v+38. (Washington, D.C.: Government Printing Office, 1951.) 20 cents. [104

Sixty-seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1949–1950. Pp. ii+25. (Washington, D.C.: Government Printing Office, 1951.) [104

Catalogues

Microscopic Staining Techniques. No. 3. Compiled and edited by Edward Gurr. Pp. 64. (London: Edward Gurr, Ltd., 42 Upper Richmond Road, S.W.14, 1951.) 3s. 6d.

Notes on Oxoid Culture Media. Pp. 28. (London: Oxo, Ltd., 1951.)

A Catalogue of recently purchased Books and Periodicals on Natural History (Zoology, Geology, Palæontology and Botany). (No. 688.) Pp. 40. (London: Bernard Quaritch, Ltd., 1951.)

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
Advertisements only should be addressed to:
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2.
Telephone Number: Temple Bar 1942
All rights reserved. Registered as a Newspaper at the General Post Office

JUNIOR AND SENIOR TECHNICIANS required for Animal Nutrition Research Laboratory at Cambridge. Applicants for the junior post must have matriculation and a keen interest in animals and working with animals and poultry. Those applying for the senior post should be of at least Inter.B.Sc. standard in either zoology or physiology, but a senior unqualified man of long experience would receive consideration. The laboratory is concerned particularly with the nutrition of farm animals, and persons with experience in this field will be given preference.—Applications, together with names of two referees, should be sent to Spillers Central Laboratory, Station Road, Cambridge.

BELLING & LEE, LTD., CAMBRIDGE Arterial Road, Enfield, Middlesex, require Research Assistants in connection with work on electronic components, fuses, interference suppressors and television aerials. Applicants must be graduates of the I.E.E., or possess equivalent qualifications, together with similar laboratory experience. Salary will be commensurate with previous experience.—Applications must be detailed and concise, and will be treated as confidential.

THE DISTILLERS CO., LTD., HAVE A vacancy in the Pilot Plant Division of the Central Research Department at Tonbridge, Kent, for a Chemical Engineer, or a Chemist desiring plant experience, for process development on pilot plant scales. Age up to 26 years. Applicants must have an honours degree in chemistry or chemical engineering, or equivalent. There are excellent opportunities for advancement. Salary will depend on qualifications and experience. Non-contributory pension scheme.—Apply, Staff Manager, 21 St. James's Square, London, S.W.1.

METALLURGIST OR PHYSICIST WITH Research experience to undertake study of grain boundary phenomena in metals. Initial salary up to £750 per annum. Also a graduate in metallurgy, research experience not essential. Initial salary up to £550 per annum.—Apply, in writing, with full details of qualifications and experience, Research Manager, B.N.F.M.R.A., Euston Street, N.W.1.

GRADUATE ELECTRICAL ENGINEER OR Physicist, sound knowledge of transmission line theory and practical experience in application of R.F. cables, to provide liaison with electronic research and industry home and abroad. Exceptional opening for right man.—Fullest details of qualifications, experience, age, etc., in confidence, to "G.E.E.," c/o Dixons, 1-9 Hills Place, Oxford Street, London, W.1.

FIRST-CLASS HONOURS GRADUATE REquired for training for production division staff of large manufacturing company in West of England. Good prospects. Pensions fund.—Write, giving full particulars and salary required, to Box 572, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

THE RESEARCH AND DEVELOPMENT DEpartment of the Distillers Co., Ltd., Great Burgh, Epsom, Surrey, has vacancies for Physical Chemists to do research on high polymers and thermosetting resins, including fundamental work in kinetics and molecular weight determination. Previous experience, preferably with polymers or thermosetting resins, is desirable but not essential. Age up to 27. Applicants must possess a university degree in chemistry. Salary will depend upon experience and qualifications. Non-contributory pension scheme.—Apply, Staff Manager, The Distillers Co., Ltd., 21 St. James's Square, S.W.1.

EXPERIENCED PHYSICIST, AGED 29-34, required for research work connected with the fundamental physical properties of vegetable fibres. Experience in this particular field is not important, but a sound knowledge of basic physics and ability to prosecute original work essential. Some interest in botany or microscopy would be an advantage. The post carries F.S.S.U. benefits. —Further details and conditions of appointment on application to the Secretary, the British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee.

ELECTRONIC TUBE DEVELOPMENT AND manufacture. Engineers and Physicists required for progressive technical and supervisory positions in our development and manufacturing departments. Successful applicants will have exceptional opportunities for advancement in the rapidly expanding electronics industry. Qualifications: Good degree in engineering or physics. Previous experience desired but not essential. Applicants graduating this year and free of National Service obligations will receive special consideration and, after appointment, will be given comprehensive training. Salary according to age and experience, but will not be less than £425 per annum for honours graduates at age 21.—Application should be made to Personnel Officer, Mullard Radio Valve Co., Ltd., New Road, Mitcham Junction, Surrey.

A SENIOR RESEARCH OFFICER (GENETIcist) is required for Malaya by a prominent group of plantation companies. The post calls for a scientist with experience of genetical work on tropical cultures, if possible with special emphasis on oil palms. Exceptional opportunity to use large research resources at own initiative for work on the frontiers of present knowledge in this field. The appointment will carry a high remuneration.—Write, with full details, to Box 926, Dorland Advertising, 18/20 Regent Street, S.W.1.

RESEARCH CHEMIST, AGED 22-28, REquired for work offering a wide and original field to a graduate possessing bacteriological and/or biochemical qualifications. Investigations will cover both fundamental and applied aspects. The post carries F.S.S.U. benefits. Conditions of appointment on application to the Secretary, the British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee.

SENIOR QUALIFIED AND EXPERIENCED Physical Chemist required by Manchester chemical factory. Position entails responsibility under chief chemist to lead small research group on high temperature and vacuum processes. Salary commensurate with qualifications and experience.—Box 556, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

GRADUATE PHYSICIST OR ENGINEER, aged about 25, is required to lead a small group concerned with the production of hydrogen thyratrons. Some experience of pulse modulation is desirable, but not essential.—Applications should be sent to the Personnel Officer (Ref. GBLC/166), Research Laboratories of The General Electric Co., Ltd., East Lane, North Wembley, Middlesex, stating age, qualifications and experience.

GRANTS & SCHOLARSHIPS

UNIVERSITY OF SHEFFIELD

Applications are invited for the J. G. Graves Medical Research Fellowship, under the terms of which the Fellow appointed will be required to undertake full-time medical research in one of the departments of the University of Sheffield (clinical or other). The value of the Fellowship will be £1,300 a year, and it is normally tenable for three years.

Applications (three copies), indicating the line of research proposed by the applicant, and including the names and addresses of three referees and, if desired, copies of not more than three testimonials, should reach the Registrar, the University, Sheffield, 10 (from whom further particulars may be obtained) by July 28, 1951. Official application forms are not provided.

A. W. CHAPMAN,
Registrar.

FOR SALE AND WANTED

LARGE EARTHWORMS, MEAL WORMS, Maggots. Ample supplies always available; 10s. and 20s. per tin, carriage paid. Despatch same day.—Tring Angling Supplies, Tring, Herts.

BECK MICROSCOPE. LONDON MODEL: 2/3 in. 1/8 in. and 1/12 in. (oil immersion) objectives. ×6 eyepiece. Mechanical stage. Good order, just overhauled. £30.—Tay, 321 Upper Richmond Road, S.W.15.

FOR SALE, COMPLETE COPIES OF "Nature," from December, 1944, up to present day. Unbound, with index. In excellent condition. Offers.—46 Highcliffe Gardens, Ilford, Essex; or phone Wan 5885.

MISCELLANEOUS

EXPERIENCED TRANSLATOR, RUSSIAN into English, chemical, metallurgical, etc., offers services; moderate fees.—Box 583, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

DEEPEES LIMITED *Microscopes and other Scientific Instruments*
35 Beak Street, Regent Street, London, W.1.
Overhauls, re-lacquering and repairs

"Sugars & Bacteria"
A monograph prepared primarily for actual users of Kerfoots Bacteriological Sugars and Biochemical Reagents. Have you had your copy of this interesting booklet?
Free on request from
THOMAS KERFOOT & CO. LTD., Vale of Bardsley, Lancashire
K53

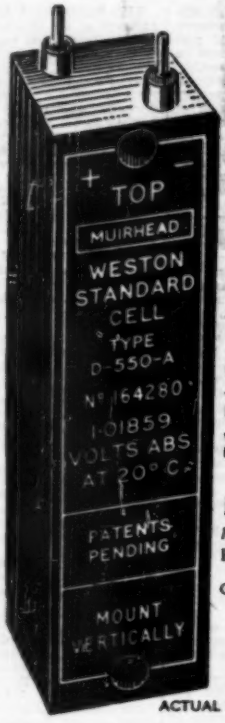
★ ★ ★ for scientific **GLASSWARE** of highest quality, especially **interchangeable JOINTS, SOCKETS and CONES,** precision ground, vacuum tested and exceptionally robust in construction.
RESEARCH UTILITIES LIMITED
LAKER ESTATE, BECKENHAM, KENT
(Syd 6223)
Excellent material plus careful service. Catalogue and prices on request. ★ ★ ★

BRAND **MICHROME** BRAND
MICROSCOPIC STAINS & REAGENTS
chosen on merit for exhibition Festival of Britain (Dome of Discovery)
Azocarmine, Acridine Yellow, Giemsa, Janus Green, May Grunwald, Nile Blue, etc.
EDWARD GURR LTD
42 Upper Richmond Rd., East Sheen, London, S.W.14
Telephones: PROspect 7606 and 8051
Now ready: "Microscopic Staining Techniques"
By EDWARD GURR, *F.L.S., F.R.I.C., F.R.M.S.*
No. 1 (24 *pp.*) 1/6. *No.* 2 (62 *pp.*) 3/6. *No.* 3 (64 *pp.*) 3/6

BECK NO. 47 LONDON

Pre-eminent in Design, Workmanship & Performance

R. & J. BECK LTD, 69 MORTIMER ST. LONDON, W1



ACTUAL SIZE

A MINIATURE STANDARD CELL

£1.13.0

(Post free in U.K.)

IMMEDIATE DELIVERY

Our other types of Standard Cells will interest you. Write for literature.

SPECIFICATION

E.M.F. 1·01859 VOLTS ABS. ±100μV AT 20°C
TEMP. COEFFICIENT 40μV/°C APPROX.
DIMENSIONS 3⅜" × 1" × ⅞" OVERALL [9·8cm. × 2·2cm. × 2·2cm.]
WEIGHT 2½ oz. [70 gm.]
MOUNTING MOULDED CASE—WITH PANEL AND CHASSIS FIXING HOLES

MUIRHEAD & Co. LTD.
Precision Electrical Instrument Makers
BECKENHAM · KENT · ENGLAND
Telephone: Beckenham 0041
Grams & Cables: MUIRHEADS ELMERS-END

PRECISION
MUIRHEAD
ELECTRICAL INSTRUMENTS

FOR THE ENTOMOLOGIST . . .

INSECT CULTURE JAR STOPPERS

These stoppers were originally designed by G. Talbot and H. Brenchley of the Infestation Control Division of the Ministry of Agriculture and Fisheries. They are intended for insect culture jars, or other containers where live insects are kept, and are in regular use at the laboratory of the Infestation Control Division and at the D.S.I.R. Pest Laboratory, Slough.

An improved version is offered in which the stopper is a rubber cork with a single wide bore hole and a 50-mesh copper gauze inserted at the small end. The closed end is therefore inside the culture jar and the upper part of the stopper provides a space which can be used for a number of purposes, such as the application of moisture or of an anaesthetic. The stopper is durable and can be sterilised by autoclaving or by immersion in boiling water.

The gauze is fitted to a metal ring which is a tight fit in the stopper. This has the advantages that the gauze can be replaced if damaged, and cleaned by solvents which attack rubber. A further advantage is the ease with which a *mite trap* can be formed by fitting a gauze insert at each end of the stopper, the space between being occupied by a compressed wad of cotton wool, kept in position by the upper gauze insert.

Prices sent on request

SEE OUR EXHIBIT AT THE BRITISH INSTRUMENT INDUSTRIES EXHIBITION
STAND NO. 2, ROW B, NATIONAL HALL, OLYMPIA—LONDON
JULY 4—14, 1951

A. GALLENKAMP & CO LTD

Manufacturers of Modern Laboratory Equipment and Scientific Apparatus

17-29 SUN STREET · LONDON · EC2

Printed in Great Britain by Fisher, Knight & Co., Ltd., The Gainsborough Press, St. Albans, and published by Macmillan & Co., Limited, at St. Martin's Street, London, W.C.2, and The Macmillan Co., 60 Fifth Avenue, New York 11, N.Y., U.S.A.—Saturday, June 16, 1951.